

PROGRAM OF THE  
**86TH ANNUAL MEETING OF THE  
AMERICAN ASSOCIATION OF PHYSICAL  
ANTHROPOLOGISTS**  
APRIL 19 – 22, 2017

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To be held at the

**New Orleans Marriott**  
555 Canal Street  
New Orleans, LA 70130

**AAPA Scientific Program Committee**

J. Josh Snodgrass, Chair

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Omer Gokcumen	Felicia C. Madimenos	Lauren Schroeder	Todd R. Yokley

**AAPA Meetings Director**

Lori Strong, Burk & Associates, Inc.

**New Orleans Advance Team**

Leslie C. Aiello	Omer Gokcumen	Heide Rohland
Susan C. Antón	Anne L. Grauer	Christopher A. Schmitt
Anthony DiFiore	Trenton W. Holliday	Lori Strong

**Program Assistant**

Julia DiFiore Rue

**Local Arrangements Committee**

Trenton Holliday (Chair)	Katharine M. Jack	Robert G. Tague	Teresa V. Wilson
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# MESSAGE FROM THE VP & PROGRAM CHAIR

It is my pleasure to welcome you to the 2017 meeting of the American Association of Physical Anthropologists. This year's meeting is our 86th, and will be held in New Orleans at the Marriott French Quarter. Our programming officially begins on Wednesday, April 19th, with the **Committee on Diversity Undergraduate Research Symposium** (open to everyone from 6-8 pm) and the **Opening Reception** (8-11 pm). This year we will kick off the main scientific program early with three invited **Plenary Poster Sessions** on Wednesday evening. These sessions address the practice and ethics of working with 'vulnerable' populations, integrating research into teaching, and training the next generation. These poster sessions will run from 8-11 pm just down the hall from the Opening Reception.

Several special committee initiatives occur before and during the meetings. Among these are: the NSF-funded 2nd annual **Committee on Diversity IDEAS (Increasing Diversity in Evolutionary Anthropology) workshop**, which will be held all day Wednesday and supports 16 student scholars participating in the AAPA meeting; local school site visits and a Saturday educators workshop by the **Education Committee**; Thursday's **Career Development Panel** (How to get funding in anthropology: A workshop on grantsmanship); and, a Thursday lunch event on mental health (**Ending the Silence on Mental Health in Biological Anthropology**). Nearly all the AAPA Committees meet or have an activity at some point during the meetings—check out the new app for their times and locations! Speaking of the app, thanks to Ed Hagen for developing our meetings app—available for Android and Apple!

This year's program includes a record 1300 scientific presentations which will be presented in podium or poster sessions on Wednesday evening or during one of the three full days of the meeting. The 71 sessions include 7 invited podium symposia, 21 invited poster symposia, 17 contributed podium sessions, and 26 contributed poster sessions. One particularly exciting event that is new this year is

the **Up Goer Five PhysAnth Edition**, which has been organized by Kim Valenta and Katherine H. Bannar-Martin. It is a series of nine 5-minute talks that challenge presenters to effectively communicate their research by using only the top 1000 most common words in the English language. This session takes place on Saturday afternoon from 4:45-5:30 pm, and clearly it can't be missed!

Our extensive program includes an impressive international group of scientists with authors from all over the world including Europe, Latin America, Africa, Asia, the Middle East, and Australia! We are pleased to be joined this year by the Paleopathology Association (PPA), the Human Biology Association (HBA), the American Association for Anthropological Genetics (AAAG), and the Dental Anthropology Association (DAA). Due to the size of our meetings we chose to contract with a second hotel—the Westin New Orleans Canal Place, located a short two blocks from the Marriott. This location will host all PPA and HBA events.

The Wiley Symposium this year is a Saturday morning podium session, **Humans as Holobionts: The Microbiome as a Biological System in Human Evolution**, organized by Stephanie Schnorr and Meagan Rubel. Our joint AAPA-HBA session, which will be held on Friday morning, is the podium session **Human Biology: Evolutionary Perspectives on Reproduction, Development, and Health**, chaired by Aaron D. Blackwell. The joint AAPA-AAAG session this year will be held on Thursday afternoon, and is an invited podium symposium titled **Collaborations across Anthropology and Genetics: Examples of Transdisciplinary Work**. It is organized by Connie J. Mulligan and Catherine Panter-Brick. Finally, the joint AAPA-PPA session, **Bioarchaeology of Transition: Health and Changing Environments**, organized by Brittany S. Walter and Sharon N. DeWitte, will be held on Thursday morning.

The significant number of abstracts submitted necessitated substantial changes to the program—our only alternative to rejecting a large number of abstracts. The biggest change is that we will be

hosting two contributed poster sessions per day (each of which includes several of its own sessions). We will be presenting a morning session from 8 am-1 pm (with authors present 12:30-1 pm) and an afternoon session from 1:30-6 pm (with authors present 1:30-2 pm); the Saturday schedule is a bit different (see below). Another key change is that the afternoon podium and invited poster sessions begin at 2:30 pm; this allows for an assortment of lunch-time events and workshops.

This year we had planned to transition away from our traditional AAPA Luncheon on Saturday (because of the high cost of the lunch) in favor of returning to holding a Plenary Lecture. However, the announcement of the **March for Science** in Washington, DC on Saturday, April 22, and its associated march in New Orleans at 1 pm, led us (in consultation with this year's planned speaker, Tony DiFiore), to cancel the Plenary Lecture and to instead reserve time so our conference attendees can march if they choose. We will convene at 12:30 pm in Carondelet where the two presidents—outgoing president Susan Antón and incoming president Leslie Aiello—will give brief remarks and then lead a procession the 8 blocks to the start of the march. To accommodate Saturday's march, morning contributed poster sessions will conclude at 12:30 pm (with authors present 12-12:30); afternoon contributed poster sessions will begin at 2:30 pm with authors present from 5:30-6 pm.

Other AAPA programming on Saturday will also resume as regularly scheduled at 2:30 with podium and poster sessions and the Presidential Panel. The **Presidential Panel**, starting at 2:30 pm, will feature a discussion of 'How can the AAPA promote a positive environment for science?'

The afternoon sessions will extend our presentations later into the evening. On Thursday evening we are excited to hold our annual **Auction**, which starts with a silent auction (5-7 pm) and ends with a live auction (7-8:30 pm), and will be emceed by auctioneer Jon Bethard. The auction regularly raises thousands of dollars to support Pollitzer Student

Travel Awards. Please participate through donations (contact organizers Valerie DeLeon, UF, or Jon Bethard, USF, if interested) and by bidding on our array of enticing auction items. Students, submit your raffle tickets for **Lunches with Luminaries** during the auction (you must be present to win!) and nominations for **Amazing Advisors**.

On Friday, following the conclusion of the scientific sessions, the annual **Business Meeting** will begin at 6:30 pm. This meeting will include acknowledgment of this year's IDEAS Scholars, Early Career Grants, and Pollitzer and COD Undergraduate Research travel awards, as well as presentations of the **Charles R. Darwin Lifetime Achievement Award** and the **Gabriel W. Lasker Service Award**. This year's Darwin Award will be presented to Alan Walker and the Lasker Award to John Relethford. Please join us in celebrating this year's winners.

Saturday evening brings with it the **Student Awards Ceremony and Closing Reception** from 6-9 pm—please join us to learn who won the 2017 Student Presentation Awards!

I am very grateful to all those who have helped assemble the 2017 program. Thanks are due to our meetings guru, Lori Strong (from Burk & Associates), as well as Ed Hagen (our webmaster and developer of a new meetings app). A huge thank you goes to the 44 members of the Program Committee and to the Advance Team. The Advance Team consisted of the Officers and representatives from Burk and the Program Committee who visited New Orleans in October. The program assistant, Julia DiFiore Rue, has been a tremendous help, as have the Officers and other members of the Executive Committee. Special thanks also to Local Arrangements Chair, Trent Holliday, and his Local Arrangements Committee. These meetings would not have been possible without these exemplary individuals, so please join me in thanking them when you see them in New Orleans!

J. Josh Snodgrass  
AAPA Vice President and Program Chair

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**Cover caption:** Canal Streetcar with the Marriott Hotel in the distance, New Orleans, Louisiana. Photo by Didier Moïse.

# KEY TO ACRONYMS

- AAAG** – American Association of Anthropological Genetics
- AAPA** – American Association of Physical Anthropologists
- AJHB** – *American Journal of Human Biology*
- AJPA** – *American Journal of Physical Anthropology*
- COD** – AAPA’s Committee on Diversity
- DAA** – Dental Anthropology Association
- HBA** – Human Biology Association
- JHE** – *Journal of Human Evolution*
- PAWMN** – AAPA Physical Anthropology Women’s Mentoring Network
- PPA** – Paleopathology Association

# EVENTS

## Monday, April 17

### PPA

**Paleopathology Association Pre-Meeting Excursion**  
10:00 am – 6:00 pm      Meet in Lobby, Westin

**Paleopathology Association Registration**  
6:00 pm – 9:00 pm      3rd Floor Prefunction, Westin

## Tuesday, April 18

### HBA

**Human Biology Association Executive Committee**  
*(closed session)*  
6:00 pm – 10:00 pm      Chairman's Room, Westin

### PPA

**Paleopathology Association Registration**  
7:45 am – 5:00 pm      3rd Floor Prefunction, Westin

**Paleopathology Association Workshop 1**  
*(Requires PPA meeting registration)*  
8:30 am – 11:00 am      Azalea 2, Westin

**Paleopathology Association Workshop 2**  
*(Requires PPA meeting registration)*  
8:30 am – 11:00 am      Azalea 1, Westin

**Paleopathology Association Podium Presentations**  
*(requires PPA meeting registration)*  
1:30 pm – 5:00 pm      Azalea Ballroom, Westin

**Paleopathology Association Student Action Committee**  
*(requires PPA Meeting registration)*  
5:00 pm – 6:30 pm      Salon Room, Westin

**Paleopathology Association Banquet & Business Meeting** *(ticketed event)*  
6:45 pm – 10:00 pm      River 127 & Terrace, Westin

## Wednesday, April 19

### AAAG

**AAAG Educational Event**  
12:00 pm – 3:00 pm      Studio 5, Marriott

### AAPA

**Speaker Ready/Press Room**  
7:30 am – 5:00 pm      Blues, Marriott

**COD Ideas Workshop** *(pre-registration required)*  
8:00 am – 5:00 pm      Studio 2, Marriott

**AAPA Executive Committee** *(board members only)*  
8:00 am – 5:00 pm      Board Room, Marriott

**Family Respite Room**  
9:00 am – 10:00 pm      Rhythm, Marriott

**AJPA Editorial Board Lunch** *(board members)*  
12:00 pm – 1:30 pm      Studio 3, Marriott

**AAPA Executive Committee & IDEAS Lunch**  
*(invitation required)*  
12:00 pm – 1:30 pm      Studio 8, Marriott

**Registration**  
2:00 pm – 7:00 pm      Ballroom Foyer, Marriott

**Student Committee Meeting**  
4:00 pm – 5:00 pm      Studio 3, Marriott

**Student Early Career Event**  
5:00 pm – 6:00 pm      Studio 3, Marriott

**AAPA COD Undergrad Research Symposium & Reception**  
5:00 pm – 8:00 pm      Acadia, Marriott  
*(open to everyone from 6:00 pm - 8:00 pm)*

**Daycare Room**  
5:00 pm – 10:00 pm      Audubon, Marriott

**Opening Reception**  
8:00 pm – 11:00 pm      Carondelet/ Bissonet, Marriott

### DAA

**DAA Workshop**  
9:00 am – 4:30 pm      Studio 7, Marriott

# EVENTS

## HBA

**AJHB Editorial Board** (*board members only*)  
7:30 am – 9:00 am Chairman's Room, Westin

**Human Biology Association Registration**  
8:00 am – 8:00 pm Foyer 2, Westin

**Human Biology Association Poster Session**  
(*requires HBA Meeting Registration*)  
8:00 am – 11:00 am Magnolia Ballroom, Westin

**Human Biology Association Breakout Session 1**  
(*requires HBA Meeting registration*)  
11:30 am – 12:30 pm River Room 1, Westin

**Human Biology Association Breakout Session 2**  
(*requires HBA Meeting registration*)  
11:30 am – 12:30 pm River Room 2, Westin

**Human Biology Association Plenary Session & Pearl Memorial Lecture** (*requires HBA Meeting registration*)  
1:00 pm – 6:00 pm Grand Ballroom, Westin

**Human Biology Association Reception & Banquet**  
(*ticketed event*)  
6:30 pm – 9:30 pm River127/ Riverbend Terrace, Westin

## PPA

**Paleopathology Association Registration**  
8:00 am – 12:00 pm 3rd Floor Prefunction, Westin

**Paleopathology Association Posters & Silent Auction**  
(*requires PPA meeting registration*)  
8:00 am – 5:00 pm Magnolia Ballroom, Westin

**Paleopathology Association Podium Presentations**  
(*requires PPA meeting registration*)  
8:30 am – 5:00 pm Azalea Ballroom, Westin

## Thursday, April 20

### AAAG

**AAAG Business Meeting**  
7:00 pm – 8:00 pm Studio 4/5, Marriott

**AAAG Cocktail Hour**  
8:00 pm – 9:00 pm Studio 6, Marriott

### AAPA

**Registration**  
7:00 am – 5:00 pm Ballroom Foyer, Marriott

**Speaker Ready/Press Room**  
7:30 am – 5:00 pm Blues, Marriott

**Daycare Room**  
7:30 am – 7:00 pm Audubon, Marriott

**Family Respite Room**  
7:30 am – 10:00 pm Rhythm, Marriott

**Exhibits**  
8:00 am – 5:00 pm Acadia, Marriott

**AAPA COD LGBTQQIAA Meeting**  
12:00 pm – 2:00 pm St Charles, Marriott

**Yearbook Editorial Board Meeting** (*board members*)  
12:00 pm – 2:00 pm Napolean, Marriott

**COD - AACT Meeting**  
12:00 pm – 2:00 pm Lafayette, Marriott

**Science Policy and Working in Government Q&A**  
12:30 pm – 2:00 pm Studio 4/5, Marriott

**PAWMN Lunch** (*pre-registration required*)  
1:15 pm – 2:15 pm Riverview 2, Marriott

**Silent Auction**  
5:00 pm – 7:00 pm Riverview, Marriott

**PAWMN Happy Hour**  
6:00 pm – 8:00 pm Preservation Hall Foyer

**Live Auction**  
7:00 pm – 8:30 pm Riverview, Marriott

**JHE Editorial Board** (*board members only*)  
7:30 pm – 10:00 pm St. Charles, Marriott

## HBA

**Human Biology Association Registration**  
7:30 am – 8:30 am Foyer 2, Westin

**Human Biology Association Podium Presentations**  
(*requires HBA Meeting registration*)  
8:30 am – 11:45 am Grand Ballroom, Westin

**Human Biology Association Awards Luncheon** (*ticketed event*)  
12:00 pm – 1:15 pm Terrace Room, Westin

**Human Biology Association Podium Presentations**  
(*requires HBA Meeting registration*)  
1:30 pm – 4:30 pm Grand Ballroom, Westin

**Human Biology Association Business Meeting**  
5:00 pm – 6:30 pm Terrace, Westin

**Human Biology Association Student Reception**  
(*requires HBA Meeting registration*)  
7:00 pm – 9:30 pm Crescent, Westin

# EVENTS

## Friday, April 21

### AAPA

<b>Registration</b>	
7:00 am – 5:00 pm	Ballroom Foyer, Marriott
<b>Speaker Ready/Press Room</b>	
7:30 am – 5:00 pm	Blues, Marriott
<b>Daycare Room</b>	
7:30 am – 7:00 pm	Audubon, Marriott
<b>Family Respite Room</b>	
7:30 am – 10:00 pm	Rhythm, Marriott
<b>Exhibits</b>	
8:00 am – 5:00 pm	Acadia, Marriott
<b>Fossil Casts</b>	
8:00 am – 5:00 pm	St. Charles, Marriott
<b>COD IDEAS Meeting</b>	
12:00 pm – 1:00 pm	Beauregard, Marriott
<b>Ethics Committee</b> ( <i>open meeting first half hour; committee members only thereafter</i> )	
12:30 pm – 2:30 pm	Galvez, Marriott
<b>COD Steering Committee</b>	
1:00 pm – 2:30 pm	Beauregard, Marriott
<b>Career Development Panel: How to get funding in anthropology: A workshop on grantsmanship</b>	
2:30 pm – 4:00 pm	Studio 10, Marriott
<b>Education Committee</b>	
5:00 pm – 6:00 pm	Galvez, Marriott
<b>AAPA Business Meeting</b> ( <i>open to all AAPA members</i> )	
6:30 pm – 8:30 pm	Bisonet, Marriott

### DAA

<b>DAA Business Meeting</b> ( <i>DAA members</i> )	
8:00 pm – 9:00 pm	Studio 4/5, Marriott

## Saturday, April 22

### AAPA

<b>Registration</b>	
7:00 am – 5:00 pm	Ballroom Foyer, Marriott
<b>COD-MAIN Comm Breakfast</b>	
7:30 am – 9:00 am	Beauregard, Marriott
<b>Daycare Room</b>	
7:30 am – 5:00 pm	Audubon, Marriott
<b>Family Respite Room</b>	
7:30 am – 10:00 pm	Rhythm, Marriott
<b>Edu Comm K-12 Teacher Workshop</b>	
8:00 am – 12:00 pm	St. Charles/ Lafayette, Marriott
<b>Speaker Ready/Press Room</b>	
8:00 am – 2:00 pm	Blues, Marriott
<b>Exhibits</b>	
8:00 am – 6:00 pm	Acadia, Marriott
<b>COD International Scholars</b>	
9:00 am – 10:00 am	Beauregard, Marriott
<b>Science March Remarks</b>	
12:30 pm – 12:40 pm	Carondelet, Marriott
<b>Presidential Panel</b>	
2:30 pm – 4:30 pm	Studio 7/8/9, Marriott
<b>AAPA Student Awards Comm</b> ( <i>committee members only</i> )	
5:00 pm – 6:00 pm	Beauregard, Marriott
<b>AAPA Student Awards and Closing Reception</b>	
6:00 pm – 9:00 pm	Carondelet, Marriott

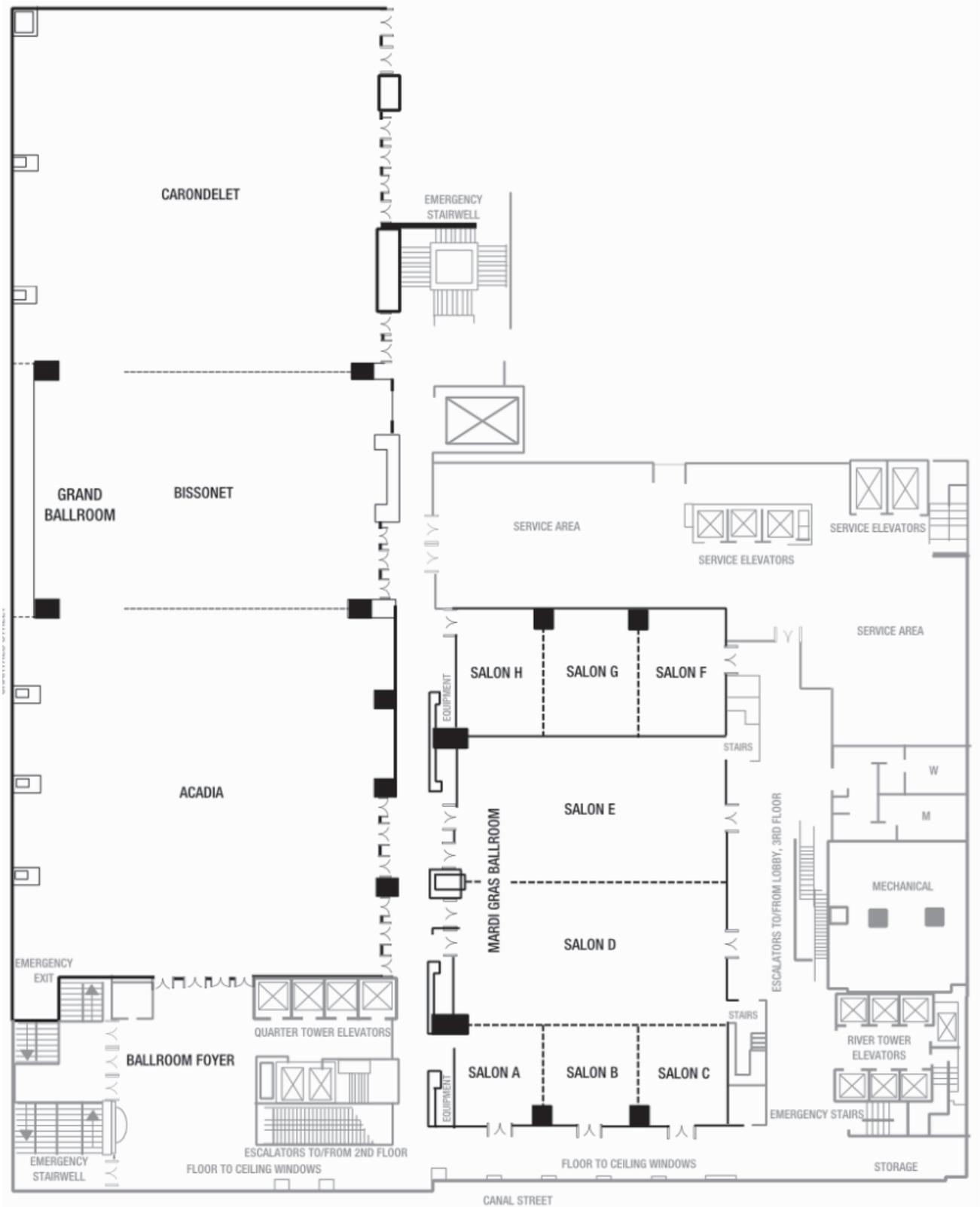
# MARRIOTT HOTEL FLOOR PLANS

## 2ND FLOOR



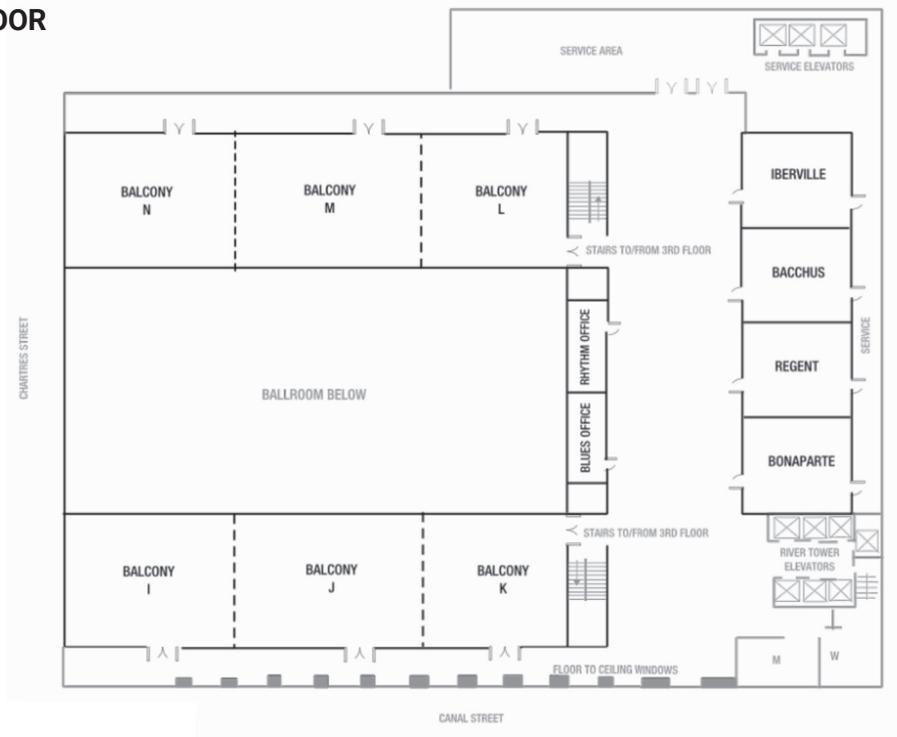
# MARRIOTT HOTEL FLOOR PLANS

## 3RD FLOOR

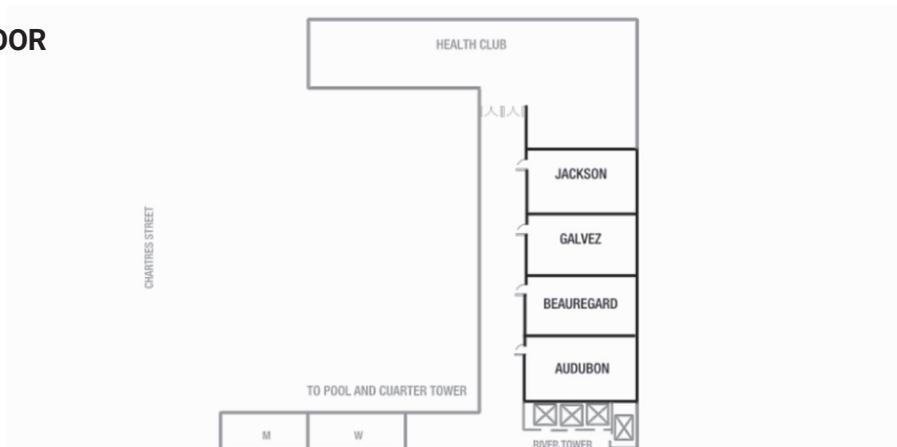


# MARRIOTT HOTEL FLOOR PLANS

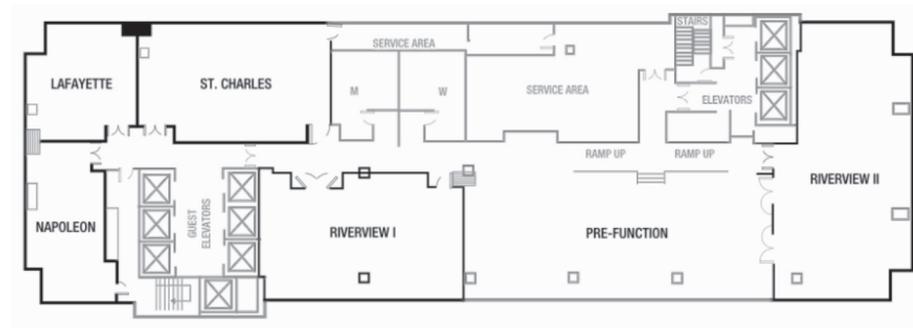
## 4TH FLOOR



## 5TH FLOOR



## 41ST FLOOR



# SCIENTIFIC PROGRAM All events take place at the Marriott Hotel

Session Title	Room	Time	Session #	Session type
<b>Wednesday, Evening</b>				
<b>American Association of Physical Anthropologists</b>				
Training the Next Generation	Acadia	8 p.m.-11 p.m.	1	Poster
Integrating Research into Teaching: Examples from Biological Anthropology	Acadia	8 p.m.-11 p.m.	2	Poster
What is a 'Vulnerable Population?' Agency, Intimacy, and Protections in Biological Anthropology	Acadia	8 p.m.-11 p.m.	3	Poster
<b>Thursday, Morning</b>				
<b>AAPA and PPA</b>				
Bioarchaeology of Transition: Health and Changing Environments	Bissonet	8 a.m.-12:15 p.m.	4	Podium
<b>American Association of Physical Anthropologists</b>				
Anthropological Genetics, Origins, Migrations, and Introgression	Balcony I/J	8 a.m.-12:15 p.m.	5	Podium
Primate Social Behavior	Studio 1/2/3	8 a.m.-12:15 p.m.	6	Podium
Paleoanthropology - Early Hominins	Studio 7/8/9	8 a.m.-12:30 p.m.	7	Podium
Child Health and Identity in Bioarchaeology	Balcony K	8 a.m.-noon	8	Poster
Back to the Root: The Use of Dental Cementum in Anthropology	Studio 4/5	8 a.m.-noon	9	Poster
Skeletal Ageing: Factors Affecting Population Variation in Rates of Bone Degeneration	Studio 6	8 a.m.-noon	10	Poster
Primate Nutrition/Foraging	Acadia	8 a.m.-1 p.m.	11	Poster
Primate Reproduction, Parentage, and Life History II	Acadia	8 a.m.-1 p.m.	12	Poster
Human Biology and Beyond	Acadia	8 a.m.-1 p.m.	13	Poster
Paleoanthropology: Early Homo II	Acadia	8 a.m.-1 p.m.	14	Poster
Functional Anatomy: Jaws and Teeth	Acadia	8 a.m.-1 p.m.	15	Poster
Human Skeletal Biology: Isotopes, Subsistence, and Mobility	Acadia	8 a.m.-1 p.m.	16	Poster
<b>Thursday, Afternoon</b>				
<b>AAPA and AAAG</b>				
Collaborations Across Anthropology and Genetics: Examples of Transdisciplinary Work	Bissonet	2:30 p.m.-6 p.m.	17	Podium

## SCIENTIFIC PROGRAM All events take place at the Marriott Hotel

<b>Thursday, Afternoon</b> <i>(continued)</i>				
<b>American Association of Physical Anthropologists</b>				
Primate Nutrition and Foraging	Balcony I/J	2:30 p.m.-6:30 p.m.	18	Podium
Primates and Evolution	Studio 1/2/3	2:30 p.m.-7 p.m.	19	Podium
Human Skeletal Biology: Life Experience, Violence, and Disease	Studio 7/8/9	2:30 p.m.-6:45 p.m.	20	Podium
Diversity, Variation, and Paleoecology: A View of Hominin Complexity from the Middle Pliocene of Eastern Africa	Balcony K	2:30 p.m.-6:30 p.m.	21	Poster
Foreign Affairs: Bioarchaeological Approaches to Ethnicity, Identity, and Interaction in The MENA Region	Studio 4/5	2:30 p.m.-6 p.m.	22	Poster
The Anthropology of Islands: Evolution, Variation, and New Research Directions	Studio 6	2:30 p.m.-6:30 p.m.	23	Poster
Primate Ecology and Conservation	Acadia	1:30 p.m.-6:30 p.m.	24	Poster
Human Biology and Genetics I	Acadia	1:30 p.m.-6:30 p.m.	25	Poster
Paleoanthropology: Late Homo	Acadia	1:30 p.m.-6:30 p.m.	26	Poster
Bioarchaeology and Paleopathology: Stress, Frailty, and Inequality	Acadia	1:30 p.m.-6:30 p.m.	27	Poster
Human Dental Anthropology: Health, Disease, and Other Cool Stuff with Teeth	Acadia	1:30 p.m.-6:30 p.m.	28	Poster
<b>Friday, Morning</b>				
<b>American Association of Physical Anthropologists</b>				
Human Skeletal Biology: Shape, Selection, Integration, and Kinship	Balcony I/J	8 a.m.-12:15 p.m.	29	Podium
Paleoanthropology: Early Homo	Bissonet	8 a.m.-12:15 p.m.	30	Podium
Primate Ecology, Cognition, and Conservation	Studio 1/2/3	8 a.m.-12:15 p.m.	31	Podium
<b>AAPA and HBA</b>				
Human Biology: Evolutionary Perspectives on Reproduction, Development, and Health	Studio 7/8/9	8 a.m.-12:15 p.m.	32	Podium
<b>American Association of Physical Anthropologists</b>				
Here Comes the Sun: Evolutionary Responses to Solar Exposure	Balcony K	8 a.m.-noon	33	Poster
Adaptation: Identifying Form-Function Relationships in the Fossil Record	Studio 4/5	8 a.m.-noon	34	Poster

## SCIENTIFIC PROGRAM All events take place at the Marriott Hotel

<b>Friday, Morning</b> <i>(continued)</i>				
<b>American Association of Physical Anthropologists</b> <i>(continued)</i>				
Anthropological Stories of Bone Histology and Remodeling: An Invited Session in Honor of Samuel D. Stout	Studio 6	8 a.m.-noon	35	Poster
Primate Social Behavior II	Acadia	8 a.m.-1 p.m.	36	Poster
Human Biology and Genetics II	Acadia	8 a.m.-1 p.m.	37	Poster
Functional Anatomy: Ontogeny	Acadia	8 a.m.-1 p.m.	38	Poster
Primates: Methods and Morphology	Acadia	8 a.m.-1 p.m.	39	Poster
Forensic Anthropology and Bioarchaeology: Collections, Ancestry, and Age at Death	Acadia	8 a.m.-1 p.m.	40	Poster
<b>Friday, Afternoon</b>				
<b>American Association of Physical Anthropologists</b>				
Beyond Visibility: How Academic Diversity is Transforming Scientific Knowledge	Balcony I/J	2:30 p.m.-5:45 p.m.	41	Podium
Signals in Evolutionary and Ecological Context	Bissonet	2:30 p.m.-6:15 p.m.	42	Podium
Human Skeletal Biology: Mobility, Isotopes, Diet	Studio 1/2/3	2:30 p.m.-6:15 p.m.	43	Podium
Primate Genetics and Adaptation	Studio 7/8/9	2:30 p.m.-6 p.m.	44	Podium
The Evolution of Form and Function in the Hominin Pelvis	Balcony K	2:30 p.m.-6 p.m.	45	Poster
The Axial Skeleton: Morphology, Function, and Pathology of the Spine and Thorax in Hominoid Evolution	Studio 4/5	2:30 p.m.-6 p.m.	46	Poster
Biological Investigations of Nomads: Developments and Innovations	Studio 6	2:30 p.m.-6 p.m.	47	Poster
Primate Cognition and Ecology	Acadia	1:30 p.m.-6 p.m.	48	Poster
Human Biology and Genetics III	Acadia	1:30 p.m.-6 p.m.	49	Poster
Paleoanthropology: Early Hominins II	Acadia	1:30 p.m.-6 p.m.	50	Poster
Human Skeletal Biology: Morphology, Variation, and Environment	Acadia	1:30 p.m.-6 p.m.	51	Poster
<b>Saturday, Morning</b>				
<b>American Association of Physical Anthropologists</b>				
Humans as Holobionts: The Microbiome as a Biological System in Human Evolution	Bissonet	8 a.m.-12:30 p.m.	52	Podium
Primate Reproduction, Parentage, and Life History	Balcony I/J	8 a.m.-12:15 p.m.	53	Podium

**SCIENTIFIC PROGRAM** All events take place at the Marriott Hotel

<b>Saturday, Morning</b> <i>(continued)</i>				
<b>American Association of Physical Anthropologists</b> <i>(continued)</i>				
Functional Anatomy of the Pelvis, Limbs, and Jaws	Studio 1/2/3	8 a.m.-12:15 p.m.	54	Podium
Later Homo Evolution	Studio 7/8/9	8 a.m.-noon	55	Podium
Anthropological Demography, Well-being, and the Osteological Paradox: A Symposium in Honor of James W. Wood	Balcony K	8 a.m.-noon	56	Poster
Skeletal Standards: Documentation Software, Databases, and Online Digitization Resources Available to Researchers	Studio 4/5	8 a.m.-noon	57	Poster
Broadening Forensic Anthropology: Bringing East and Southeast Asia to the Forefront	Studio 6	8 a.m.-noon	58	Poster
Human Biology and Genetics IV	Acadia	8 a.m.-12:30 p.m.	59	Poster
Fossil Primates and Environments	Acadia	8 a.m.-12:30 p.m.	60	Poster
Bioarcheology and Paleopathology: Violence, Activity, Infection, and Congenital Conditions	Acadia	8 a.m.-12:30 p.m.	61	Poster
<b>Saturday, Afternoon</b>				
<b>American Association of Physical Anthropologists</b>				
Primates and Dietary Ethanol: Evolutionary Outcome, or Modern Accident?	Bissonet	2:30 p.m.-6 p.m.	62	Podium
Up Goer Five PhysAnth Edition: Communicate Your Science Using English's Ten Hundred Most Common Words	Studio 7/8/9	4:45 p.m.-5:30 p.m.	63	Podium
Human Adaptive Variation/Integrative Approaches	Balcony I/J	2:30 p.m.-6 p.m.	64	Podium
Primate Evolutionary Morphology	Studio 1/2/3	2:30 p.m.-6:15 p.m.	65	Podium
Division of Fossil Primates, Duke Lemur Center – 40th Anniversary Symposium	Balcony K	2:30 p.m.-6 p.m.	66	Poster
The Paleobiology of Upper Paleolithic / Later Stone Age Humans	Studio 4/5	2:30 p.m.-6 p.m.	67	Poster
Stable Isotope Advances in Studies of Stress and Disease	Studio 6	2:30 p.m.-6 p.m.	68	Poster
Functional Anatomy of the Limbs	Acadia	2:30 p.m.-6 p.m.	69	Poster
Human Skeletal Biology: Population History and Beyond	Acadia	2:30 p.m.-6 p.m.	70	Poster
Forensic Anthropology and Bioarchaeology: Sex, Comingling, Postmortem Interval, and Decomposition	Acadia	2:30 p.m.-6 p.m.	71	Poster

# WEDNESDAY, EVENING SESSIONS

## Session 1

### Training the Next Generation

#### Invited Poster Symposium

*Organizers/Chairs: April Sievert, Teresa Nichols*

Acadia

This symposium aims to create a space for professionals at various stages of their careers to reflect on core knowledge and skills that the next generation of bioanthropologists needs to address the ever-broadening research questions and methodologies available to the scientific community. A parallel area of discussion encourages educators to consider what content they are focusing on in their courses, in their field schools or laboratories, and during mentoring. The study of humanity necessitates an engagement with the ethics of conducting research on human subjects and research that holds profound implications for different human populations. As the AAPA Ethics Committee becomes a standing committee and is developing a fellows program and case studies initiative for teaching purposes, this is an important moment to reflect broadly about the central values that should be supported in the up and coming generation of professionals. This symposium offers a variety of perspectives, tackling issues ranging from the importance of inclusive learning environments to professional skills a career bioanthropologist might need. Furthermore, it encourages professionals to reflect on the many stakeholders who are interested and affected by research questions and methods and new possibilities for collaboration. We hope that educators and students alike will be engaged by these reflections on pedagogical and disciplinary values and the challenges and opportunities that lie ahead.

8:00 Individual poster presentations

9:30 Discussant: Dennis O'Rourke

- 1 **What SLACS might lack: Teaching Biological Anthropology and ethics at a small liberal arts college.** A.M. KAKALIOURAS
- 2 **Engaging undergraduate students in research.** S.R. WILLIAMS.
- 3 **What Biological Anthropology Can Teach Us about Conflict and Social Inequality: Teacher and Student Reflections.** R.P. HARROD, N.M. JOHNSON, A.A. HANNIGAN, M.A. KINCAID.
- 4 **Growth and opportunities in graduate education: A student's perspective.** B.M. HOLLISTER.
- 5 **Advancing ethical literacy through case studies.** K.M. ZARENKO, J. EYRE.
- 6 **Engendering identity to anatomical collections: Using history, embodiment theory, and ethics to humanize skeletons.** C.M. DE LA COVA.

- 7 **Human remains and vodou practitioners in northern Haiti: Ethics and research design in ethnoarchaeology.** P.L. GELLER.
- 8 **Anthropology education in the age of NAGPRA: Where we stand and where we might go.** A.K. SIEVERT, T. NICHOLS.
- 9 **Building bridges: Learning to use science and indigenous knowledge to create productive partnerships.** D.A. BOLNICK, R.S. MALHI.
- 10 **NAGPRA in Practice: Moving from the Classroom to Collaboration.** J. THOMAS.
- 11 **Communicating early career research: The importance of outreach.** J.A. RAFF.

## Session 2

### Integrating Research into Teaching: Examples from Biological Anthropology

#### Invited Poster Symposium

*Organizers/Chairs: Laurie Kauffman, Kerry Dore*

Acadia

The Anthropologists outside of Anthropology departments, Contingent, and Teaching-focused faculty (AACT) Task Force, under the umbrella of the Committee on Diversity, was formed at the 2014 annual meeting of the American Association of Physical Anthropologists. This group began in order to serve the needs of AAPA members outside of traditional research faculty roles. Each year since its inception, the group has sponsored a poster session or panel discussion on topics of interest to our members. This poster session is the group's event for 2017. Many members of the AAPA are affiliated with academic institutions of higher learning with some teaching responsibilities, and increasing numbers of AAPA members are employed with teaching as their primary responsibility. In addition, current research demonstrates that inquiry-based learning, active learning, and participation in undergraduate research helps students succeed in higher education. All of these methods make students responsible for their own learning, help them create knowledge, and give them broader skills needed for successful careers. Further, more and more biological anthropologists are becoming involved in the scholarship of teaching and learning, which provides evidence-based solutions to teaching problems. This symposium showcases how biological anthropologists integrate teaching and research through a diversity of methods. Here we present examples of teaching and research working together, from scholarship on teaching and learning done in the classroom, to integrating research with classes in liberal arts and small college environments, to managing undergraduate researchers. This symposium will serve as a space for biological anthropologists to gain inspiration and acquire tools to help them integrate research into their classrooms.

## WEDNESDAY EVENING SESSIONS

- 1 **Student Biological Anthropology Research in the Liberal Arts Environment: What to Do Without a Zoo** V.K. BENTLEY-CONDIT.
- 2 **Integrating Major Original Research Projects into Undergraduate-level Courses.** L. KAUFFMAN.
- 3 **Students as Scholars in the field, lab, archive, and table: Models of undergraduate research in biological anthropology.** B.M. USHER.
- 4 **No monkeys on campus? Engaging undergraduates using local natural history.** M. BEZANSON, T. GROVES.
- 5 **Does a notecard “cheatsheet” help bio anth students on exams?.** J.L. WESTIN.
- 6 **From Foundational Concepts to Critical Reflection: Building Student Understanding in Introductory Courses.** E. SOLURI.
- 7 **Teaching critical thinking skills through the scientific method: a comparison of different levels of active engagement.** M.S. SCHAEFER.
- 8 **Cultivating collaboration through student-centered independent study.** J. DANZY CRAMER.
- 9 **Crossing the divide: co-teaching human diversity and evolution to advanced biology and anthropology undergraduate students through the use of interdisciplinary research groups.** D.E. BLOM, A.L. YONAN
- 10 **“What makes us human?” A question to engage students, the public, and research.** A.R. ELLER, K.M. DORE.

### Session 3

#### **What is a ‘Vulnerable Population?’ Agency, Intimacy, and Protections in Biological Anthropology**

##### **Invited Poster Symposium**

*Organizers/Chairs: Kathryn B. H. Clancy, Ripan Malhi, Alejandra Núñez-de la Mora*

Acadia

‘Vulnerable’ is often used to discuss the populations we conduct research on, ranging from small forager groups to pregnant women to orphans. This label carries with it a number of challenges. First, the label of ‘vulnerable’ used by many Institutional Review Boards comes from a specific, Western context that may not match participants’ view of themselves. This at times complicates IRB protections, and sometimes calls into question whether the concerns of IRBs are the appropriate concerns for

non-Western participants. Second, this label can deny agency to the participants with whom we work, and keep them from being involved in the scientific research conducted in their homes and on their bodies. Collecting biological materials and conducting interviews on sensitive topics are intimate experiences where we can find ourselves becoming paternalistic, rather than egalitarian, stewards of the data we collect and people we collect it from. Finally, we need to acknowledge that research success is sometimes predicated on participants staying ‘vulnerable’ – for instance, that traditional foragers remain foragers rather than transition to a market-based economy, orphans remain unadopted, some portion of the pregnant women we study have complications. How do we acknowledge the difficult moments we measure and document while creating opportunities for improvements in the lives of our participants? In recent years, biological anthropologists have borrowed and devised several research models in order to balance on the tightrope of providing adequate research protections and prioritizing the agency of research participants. To what extent are these models working? To what extent are they influencing communities in which they are used? Are there ways in which our research invades or influences their contexts? We offer a symposium of scholars who are directly engaged with these questions in their research, as well as in their roles on IRBs and funding agencies.

9:00 **Discussants: Alejandra Núñez-de la Mora and Kathryn B. H. Clancy.**

- 1 **Community-based approaches to genomic research with Indigenous peoples of North America.** R.S. MALHI, A.C. BADER, M.P. ROGERS.
- 2 **Vulnerability: Going Beyond the Physical to the Spiritual to Understand Indigenous Health in the Amazon.** P.S. TALLMAN.
- 3 **Agency and objectivity: Working together towards better science.** H. SHATTUCK-HEIDORN.
- 4 **Zika, Maternal Stress and Prematurity in Puerto Rico: Navigating Unforeseen Vulnerabilities.** M. CHEYNEY, H. HORAN.
- 5 **Evolutionary perspectives on dementia and the marginalization of the elderly.** M. FOX.
- 6 **Considering Vulnerability in War-affected and Forcibly Displaced Populations.** P.F. CLARKIN.
- 7 **The Wrong Side of the Tracks: How Sociocultural Expectations Produce Vulnerability and Risk for Urban Mobile Home Dwellers.** A. FORMANACK.
- 8 **Reflecting at 99: Engaging Ethics in the AJPA.** J.K. WAGNER.

# THURSDAY, MORNING SESSIONS

## Session 4

### Bioarchaeology of Transition: Health and Changing Environments

#### Invited Podium Symposium

*Organizers/Chairs: Brittany S. Walter, Sharon N. DeWitte*

*Bissonet*

Changing environmental conditions have the potential to affect human health. Numerous bioarchaeological studies have addressed the health consequences of transitional periods in the past, particularly those accompanied by the emergence of greater social and economic complexity, and they have often produced contradictory results. For example, it has been argued that the shift from foraging to agriculture precipitated changes in nutrition, population density, and disease load that resulted in worsened health, as reflected in increased frequencies of lesions in agricultural skeletal assemblages. However, others argue that these skeletal data could also be reflective of potential improvements in health after the transition. These, and other contradictory findings, suggest that inferences about secular changes in health in the past require approaches that move beyond relatively simple tests of association between changing environments and frequencies of pathologies in skeletal assemblages. Bioarchaeologists must take into account population heterogeneity, evolution of pathogen virulence, migration, diet, cultural variability, and changes in fertility, among other factors. Bioarchaeologists should also incorporate analytical approaches that accommodate multiple interacting factors and integrate several lines of evidence (e.g. stable isotopes, primary documents, and archaeological material) to construct comprehensive interpretations of health during periods of change. This symposium showcases research that investigates how human health has changed in response to transitional contexts in the past, such as agricultural intensification, urbanization, contact, colonization, industrialization, and globalization. Research investigating these transitional periods could reveal information about the evolution of human health, how different groups experience transitional environments, and could potentially be valuable for living populations currently undergoing transitions. The symposium ultimately aims to show how the effect of transitional periods on humans is not necessarily uniformly detrimental to health and may be experienced differently by subpopulations (e.g. age groups, the sexes, socioeconomic statuses), and should thus be investigated comprehensively and within an appropriate context.

- 8:00 Biosocial Changes in Health before Agriculture: The Case of the Natufian Hunter-Gatherers. A.J. STUTZ, F. BOCQUENTIN.
- 8:15 Adaptation and resiliency in hunter-gatherers: approaches to environmental variation in prehistoric hunter-gatherers of the Jomon period. D. TEMPLE.
- 8:30 Site dissection as a tool for microscale inferences of health and dietary transitions. A.R. HOFF, C.M. STOJANOWSKI.
- 8:45 The Development of the Mid-Continental U.S. Vacant Quarter: The Impact of Aggregation, Warfare and Climate Change on Late Pre-Columbian Population Dynamics. J.J. WILSON.
- 9:00 Reproductive Value across the Holocene: 8,000-years of Transitions. R.R. PAINE, J.L. BOLDSSEN.
- 9:15 The Earliest Urban Environment in Precolumbian Mesoamerica: Transitions through Time in Health and Morbidity in the Residents of Teotihuacan, Mexico. R. STOREY.
- 9:30 4,000 Years of Cultural and Adaptive Transitions in Lambayeque: Skeletal Biology, Ecology, and Sociopolitical Interplays in Ancient Peru. H.D. KLAUS.
- 9:45 Urbanizing Medieval London: Temporal Changes in Survivability. B.S. WALTER.
- 10:00 Break.
- 10:30 Alms for the Poor? Poverty, stress, and mortality in industrial-era Albany, New York. G.M. HUGHES-MOREY.
- 10:45 Isotopic evidence for diet in Iron Age and Roman Apulia – conformity in the face of major social change? T.L. PROWSE, L. SEMCHUK.
- 11:00 Modeling dietary variability in Middle Period San Pedro de Atacama, northern Chile. W.J. PESTLE, C. TORRES-ROUFF, M. HUBBE.
- 11:15 Let them eat corn: Cause-specific mortality and prehistoric population dynamics in transitional environments. A.L. WARREN, L. SATTENSPIEL, A.C. SWEDLUND.
- 11:30 Treponematosi in indigenous North America: Bioarchaeological perspectives on the epidemiological landscape of a spirochete disease. P.M. LAMBERT.
- 11:45 Ancient Parasites and Transition: Using Intestinal Infections to Track the Impact of Human Lifestyle Change. P.D. MITCHELL.
- 12:00 Discussant: Jane Buikstra.

## THURSDAY MORNING SESSIONS

### Session 5

#### Anthropological Genetics, Origins, Migrations, and Introgression

##### Contributed Podium Presentations

Chair: Verena J. Schuenemann

Balcony I/J

- 8:00 Y-chromosome STR analysis of ancient individuals from British Columbia. A.C. OWINGS, J.S. CYBULSKI, R.S. MALHI.
- 8:15 A mitochondrial DNA study of the Beothuk and Maritime Archaic, extinct aboriginal populations from Newfoundland and Labrador. A.T. DUGGAN, A. HARRIS, S. MARCINIAK, I. MARSHALL, V. GRIMES, H. POINAR.
- 8:30 Genetic structure of populations of the Aleutian Archipelago based on 750,000 SNPs. M.H. CRAWFORD, S.D. ALDEN, R. DAVID, K.G. BEATY.
- 8:45 Migration, admixture and genetic continuity in pre and post-contact Puerto Rico. M.A. NIEVES-COLON, W.J. PESTLE, J. BENN-TORRES, A.C. STONE.
- 9:00 Analysis of Mexican American full genome DNA sequences identifies 137 SNPs of unique Native American origin. S.D. NIEDEBALKI, J.C. LONG.
- 9:15 The genomic history of the First Australians. A. MALASPINAS, M.C. WESTAWAY, S. SUBRAMANIAN, J. WRIGHT, L. DAVID, E. WILLERSLEV.
- 9:30 Studying population genetics in war time: Syria and Iraq according to *Genographic* database. M. SHAMOON-POUR, G. VILSHANSKY, M.G. VILAR.
- 9:45 Ancient Egyptian mummy genomes suggest an increase of Sub-Saharan African ancestry in post-Roman periods. V.J. SCHUENEMANN, A. PELTZER, W. HAAK, S. SCHIFFELS, J. KRAUSE.
- 10:00 Break.
- 10:30 Levantine and southern Arabian populations share many Neanderthal SNPs. D.N. VYAS, A. AL-MEERI, C.J. MULLIGAN.
- 10:45 Diverse Patterns of Neanderthal Introgression in Western Asia. R.O. TASKENT, D. ALIOGLU, E. FER, H.M. DONERTAS, M. SOMEL, O. GOKCUMEN.
- 11:00 Archaic hominin introgression in Africa contributes to functional salivary *MUC7* genetic variation. D. XU, P. PAVLIDIS, N. ALACHIOTIS, C. FLANAGAN, R. BLEKHMANN, S. RUHL, O. GOKCUMEN.
- 11:15 Simultaneous Estimates of Archaic Admixture and Ancient Population Sizes. A.R. ROGERS, R.J. BOHLENDER.

- 11:30 Neolithic familial migration contrasts Bronze Age male migration inferred from ancient X chromosomes. A. GOLDBERG, T. GUNTER, N.A. ROSENBERG, M. JAKOBSSON.
- 11:45 Ancient DNA Analysis of a Late 17th Century Plantation site in Delaware Yields Considerable Matrilineal Diversity and Relatedness in Early Colonists. R.E. FLESKES, F. WEST, G.S. CABANA, T.G. SCHURR.
- 12:00 Dynamics of clans in Human Unilineal populations: a genetic approach. B. ALARD, G. LY, R. LAURENT, S. LAFOSSE, C. MONIDARIN, G. DIFFLOTH, O. EVRARD, F. BOURDIER, S. PAVARD, R. CHAIX.

### Session 6

#### Primate Social Behavior

##### Contributed Podium Presentations

Chair: Adrian V. Jaeggi

Studio 1/2/3

- 8:00 Adolescent male aggression toward adult females represents dominance striving, not sexual coercion, in wild chimpanzees. D.K. ENIGK, M. EMERY THOMPSON, Z.P. MACHANDA, R.W. WRANGHAM, M.N. MULLER.
- 8:15 Reciprocity can explain grooming, but not other forms of cooperation, among female bonobos at LuiKotale, DRC. A.V. JAEggi, L.R. MOSCOVICE, L.G. GOLDSTONE, G. HOHMANN, B. FRUTH.
- 8:30 Female strategies during intergroup aggression among tufted capuchin monkeys (*Sapajus nigritus*). C.J. SCARRY.
- 8:45 Male ranging behavior and cooperative territorial defense in white-bellied spider monkeys (*Ateles belzebuth*). A. DI FIORE, A. LINK.
- 9:00 Evolutionary patterns of intersexual power: The rise of male dominance in primates. R.J. LEWIS, E. KIRK, A.D. ASHLEY GOSSELIN-ILDARI.
- 9:15 Impact of behavioral traits on diversification rates in primates. A. LASERNA, J.P. HERRERA.
- 9:30 Adolescent male chimpanzees form strong and differentiated social bonds with maternal brothers and old adult males. A.A. SANDEL.
- 9:45 The link between social networks and gut microbial composition in black-and-white colobus (*Colobus vellerosus*). E.C. WIKBERG, D. CHRISTIE, F.A. CAMPOS, P. SICOTTE, N. TING.
- 10:00 Break.

## THURSDAY MORNING SESSIONS

- 10:30 Attention to social grooming among immature East African chimpanzees (*Pan troglodytes schweinfurthii*) of the Kanyawara community at Kibale National Park. K. SABBI, M. EMERY THOMPSON, M.N. MULLER, Z. MACHANDA, E. OTALI, R.W. WRANGHAM.
- 10:45 Socializing by vocalizing: a test of the vocal grooming hypothesis in the gelada (*Theropithecus gelada*). E.T. TINSLEY JOHNSON, N. SNYDER-MACKLER, T.J. BERGMAN, J.C. BEEHNER.
- 11:00 Dual rank attainment strategies by male chimpanzees in Gombe National Park, Tanzania. J.T. FELDBLUM, E.E. WROBLEWSKI, R.S. RUDICELL, Y. LI, B.H. HAHN, C. KRUPENYE, A.E. PUSEY, I.C. GILBY.
- 11:15 Group augmentation explains territorial boundary patrolling by male chimpanzees at Ngogo. K.E. LANGERGRABER, D.P. WATTS, L. VIGILANT, J.C. MITANI.
- 11:30 Dispersal is socially, but not energetically costly, in female chimpanzees of Gombe National Park. K.K. WALKER, C.M. MURRAY, A.E. PUSEY.
- 11:45 Coping with death: behavioral mitigation of the loss of an alpha male by female chacma baboons in South Africa. S. CHOWDHURY, L. SWEDDELL.
- 12:00 Examining social stress through self-directed behavior in wild orangutans. C.A. O'CONNELL, C.D. KNOTT.
- 9:00 Functional morphology and evolution of the early hominin forefoot. P.J. FERNÁNDEZ, C.S. MONGLE, B.A. PATEL, M.W. TOCHERI, W.L. JUNGERS.
- 9:15 A chimpanzee-sized ancestor of the earliest hominins and unusual patterns of body size evolution in the hominid clade. M. GRABOWSKI, W.L. JUNGERS.
- 9:30 Lucy's Knee: Evidence of a High-energy Dislocative Compressive Epiphyseal Fracture. J. KAPPELMAN, R.A. KETCHAM, S. PEARCE, L. TODD, W. AKINS, M. FESEHA, S.J. MATTOX, A. WITZEL.
- 9:45 Jaw kinematics in South African Plio-Pleistocene hominins inferred from maxillary molar root morphology: Implications for species identification. K. KUPCZIK, V. TORO-IBACACHE, G.A. MACHO.
- 10:00 Break.
- 10:30 A new reconstruction of the Sts 14 pelvis supports a human-like birth mechanism in *Australopithecus africanus*. J. EYRE, S.A. WILLIAMS.
- 10:45 The evolutionary and ontogenetic context of fossil hominin scapulae. D.J. GREEN, T.A. SPIEWAK, J.P. KELLY, B.C. SEITELMAN, J.R. KRECIOCH, P. GUNZ, Z. ALEMSEGED.
- 11:00 Micro-CT Evaluation of Femoral Neck Cortical Distribution in South African Fossil Hominins. A.G. CLAXTON, K.J. CARLSON.
- 11:15 Dental pathology, wear, and developmental defects in South African hominins. I. TOWLE, J.D. IRISH, I. DE GROOTE.
- 11:30 Discrete dental traits differentiating *Australopithecus africanus* and *Paranthropus robustus* evaluated from the perspective of a Great Ape Dental Scoring System. V.C. PILBROW.
- 11:45 Effect of Cusp Number on the Structural Integrity of Early Hominin Teeth. P.J. CONSTANTINO, M.B. BUSH, A. BARANI, B.R. LAWN.
- 12:00 *Australopithecus sediba* and the Origin of *Homo*: Questionable Evidence from the Cranium of the Juvenile Holotype MH 1. W.H. KIMBEL, Y. RAK.
- 12:15 Reconsidering Mid-Pliocene Hominin Ecology in the Turkana Basin, Kenya: Integrating Vegetation, Sedimentary, and Mammalian Community Reconstructions to Explore Hominin Sympatry. A. VILLASEÑOR, A.K. BEHRENSMEYER, R. BOBE.

### Session 7

#### Paleoanthropology - Early Hominins

##### Contributed Podium Presentations

Chair: Rhonda L. Quinn

Studio 7/8/9

- 8:00 Calcar Femorale Development in *Orrorin tugenensis* Femora Provides Further internal Evidence for Bipedal Locomotion. A.J. KUPERAVAGE, S. CHAVANAVES, R. ECKHARDT.
- 8:15 Paleoecological reconstructions of c.4 Ma hominin sites from the Omo-Turkana Basin using fossil Bovidae. L. DUMOUCHEL, R. BOBE.
- 8:30 Reinvestigation of the ~4 Ma Yellow Sands of the Mursi Formation. M.S. DRAPEAU, J.G. WYNN, D. GERAADS, L. DUMOUCHEL, C.J. CAMPISANO, R. BOBE.
- 8:45 Oxygen isotopic correlates of diet and drinking behavior in extant mammals from Laikipia, Kenya: implications for gauging Pliocene Turkana hominin paleoecology. R. QUINN, C. RYDER, J. LEWIS, B. POBINER, O. MWEBI.

## THURSDAY MORNING SESSIONS

### Session 8

#### Child Health and Identity in Bioarchaeology

##### Invited Poster Symposium

*Organizers/Chairs: Mary Lewis, Sian Halcrow, Rebecca Gowland*

##### Balcony K

A child's skeleton provides a rich repository of information relating to their physical and social worlds. This evidence, when properly contextualised, may be successfully harnessed by bioarchaeologists to explore such diverse aspects of childhood, including care and cultural constructions of the life course, the fluidity of gender and status identity with age, local disease ecologies, activities such as play and occupation, and even cases of physical abuse. Children have emerged as important social actors in the past as individuals who exercise considerable agency, and whose presence and societal contributions are vital to properly consider when interpreting the archaeological record. Bioarchaeologists are increasingly aware of the importance of younger members of society in our understanding of past cultures and lifeways. Children, particularly perinates and infants, are now regarded as crucial to assessing maternal health, adult morbidity patterns and longevity. Exposure to malnutrition or infectious diseases during the early stages of our development are recognised to have detrimental effects on health during adulthood and for our offspring. As vulnerable members of a society, wholly dependent on the care of others, understanding the survival of infants has the potential to provide an accurate measure of a population's ability to adapt to their particular environmental circumstances. Our questions are becoming ever more sophisticated as we broaden our focus away from issues of representation of children and mortality rates to questioning specific issues that surround a child's identity from infancy to adolescence, and the unique circumstances that influence their health and survival.

10:30 Discussant: Sian Halcrow.

- 1 **Stressful Starts: Investigating the impact of 'stressors' on fetal, perinatal and infant health and growth through time.** C.M. HODSON, R.L. GOWLAND.
- 2 **Childhood Survival and Perinatal Stress: A Case Study from Northern Peru.** J.A. THOMAS, D.H. TEMPLE, H.D. KLAUS.
- 3 **Growing up is hard to do: growth in urban and rural non-adults from Roman Britain.** A.J. ROHNBIGNER.
- 4 **Mouths to Feed: Subsistence Transition and Childhood Health in the Ancient Atacama Desert, Northern Chile (ca 5,500 – 1,500 BP).** A.E. SOHLER-SNODDY, S.E. HALCROW, H.R. BUCKLEY, V. STANDEN, B. ARRIAZA.

- 5 **Life in the shadows: the impact of social status, geographic location, and vitamin D deficiency on child health in 18th-19th century England.** S.L. NEWMAN.
- 6 **Indentured: Bioarchaeological Evidence for Pauper Apprentices in Nineteenth Century Yorkshire, England.** R.L. GOWLAND, A. CAFFELL, M. ALEXANDER, L. QUADE, A. MILLARD, M. HOLST, P. YAPP, C. BROWN.
- 7 **Invisible transitions: the search for new osteological signatures of menarche.** M.E. LEWIS, F. ELAMIN.
- 8 **Plagiocephaly and the maternal-fetal interface at Harappa.** G. ROBBINS SCHUG.
- 9 **A Comparative Growth Analysis of African Child Slaves in 15th to 17th Century Portugal.** L. SPAKE, M. FERREIRA, H.F. CARDOSO, S. WASTERLAIN.
- 10 **Small but healthy? The Shape of Childhood.** S.Y. STARK, S. MAYS, J.R. SOFAER, S.R. ZAKRZEWSKI.
- 11 **When to wean? The complex interaction between weaning behaviour, physiological stress and individual decision-making in the children of the Atacama Desert.** C.L. KING, S.E. HALCROW, A.R. MILLARD, D.R. GRÖCKE, V.G. STANDEN, B.T. ARRIAZA.
- 12 **Agriculture in the Atacama Desert: Implications for Human Health and Development.** G.E. ELLIOTT, S. HALCROW, H. BUCKLEY, A. GRAY, V. STANDEN, B. ARRIAZA.

### Session 9

#### Back to the Root: The Use of Dental Cementum in Anthropology

##### Invited Poster Symposium

*Organizers/Chairs: Stephan Naji, William Rendu, Lionel Gourichon*

##### Studio 4/5

Tooth enamel and dentin are the most studied hard tissues used to explore hominin evolution, life history, diet, health, and culture. Surprisingly, cementum (the interface between the alveolar bone and the root dentin) remains the least studied dental tissue even though its unique growth, which is continuous throughout life, has been acknowledged since the 1950's. However, the hypothesized seasonal cementum increments have been successfully used to estimate accurate age and season at death in over 70 mammal species including human, and has opened a range of invaluable interpretative opportunities. Yet archaeological applications have been particularly limited by the lack of understanding of cementogenesis and the controversial nature of the observed increments. Following our initial meeting in 2013 on cementum studies, this symposium is the first attempt to bridge the gap between faunal and human analyses and to illustrate the growing multidisciplinary uses of cementum in

## THURSDAY MORNING SESSIONS

anthropology. The recent implementation of synchrotron x-ray imaging technologies in fluorescence mapping and micro-tomography provides new insight into cementum microstructure. Bioarchaeology and forensic age and season at death estimations now benefit from standardized protocols, as well as a greater understanding of taphonomic alterations and how to deal with them in archaeological and forensic samples. Finally, paleoanthropology can profit from nondestructive virtual cementum analyses to explore dental sexual dimorphism and morphology in hominin remains. With the recent advances in microbiology imaging technologies, and the consequent renewed awareness of cementum growth potentials, anthropologists are finally going back to the root.

10:30 Individual poster presentations and discussion led by Daniel Antoine.

- 1 **Cementum ultrastructure, a comparative perspective from synchrotron x-ray scanning: fluorescence and diffraction.** S. NAJI, W. RENDU, L. GOURICHON, Z. CAI, S. STOCK.
- 2 **Taphonomy in cementochronology.** W. RENDU, A.J. STUTZ, L. GOURICHON, S. NAJI, M. VUILLIEN, C. SÁNCHEZ-HERNÁNDEZ, E. PUBERT.
- 3 **New insights on Broad Translucent Annulations.** T. COLARD, M. DUBOIS, A. DE BROUCKER, B. BERTRAND.
- 4 **Computerized cementochronology - taking the (16)bit between the teeth.** B. BERTRAND, J. RAMOS MAGALHAES, T. COLARD.
- 5 **Imaging cementum in primate deciduous teeth using synchrotron phase contrast micro-tomography.** A. LE CABEC, M. TOUSSAINT, D.R. BEGUN, P. TAFFOREAU, C. DEAN.
- 6 **Sexual dimorphism in dental cementum microstructure: potential for sexing hominin remains.** K. ROBSON BROWN, E. NEWHAM, P. BAYLE, I. CORFE, P. GILL.
- 7 **Synchrotron x-ray microtomography for non-destructive adult age-at-death estimation: visualizing cementum annulations in a historical human assemblage.** N. TANG, A. LE CABEC, S. HILLSON, P. TAFFOREAU.
- 8 **Development of Dental Cementum Increment Analysis for Age at Death Determination within the Identification Process of Unaccounted-for US Service Members.** K. KOEL-ABT, N.D. WILSON, K.N. SCHMIDT.
- 9 **The Utility of Dental Cementum Increment Analysis for Estimating Season-of-Death in Naturally Decomposed Skeletons.** L.A. MECKEL, D.J. WESCOTT.
- 10 **Determination of Season at Death Using Dental Cementum Increment Analysis to Assist in the Identification Process of Unaccounted-for US Service Members from Past Conflicts.** N.D. WILSON, K. KOEL-ABT, K.N. SCHMIDT.
- 11 **Out of the Mouths of Babes: Cementum Annulations in Human Deciduous Teeth.** V.L. WEDEL, K.P. HERMSEN.
- 12 **Cementochronology to the rescue: Osteobiography of a Middle Woodland woman with a combined skeletal dysplasia.** A.A. CORMIER, J.E. BUIKSTRA, S. NAJI, T. COLARD.
- 13 **Cementochronology and Palaeodemography: A New Method to Assess the Probable Age Distribution of Immatures.** L. LANTERI, B. SALIBA-SERRE, B. BIZOT, J. GAUDART, M. SIGNOLI, A. SCHMITT.
- 14 **Assessing Age-Related Mortality at Petra, Jordan Using Cementochronology and Hazard Modeling.** A.S. PROPST, M. PERRY.
- 15 **Seasonality and Neanderthal hunting strategies.** L. GOURICHON, W. RENDU, S. NAJI, M. HASSANI, E. PUBERT, C. SANCHEZ-HERNANDEZ.

### Session 10

#### **Skeletal Ageing: Factors Affecting Population Variation in Rates of Bone Degeneration**

##### **Invited Poster Symposium**

*Organizers/Chairs: Vanessa Campanacho,  
Andrew T. Chamberlain*

**Studio 6**

A persistent problem in physical anthropology is the lack of accuracy in age estimation for adult skeletons, especially when analysing macroscopic degenerative changes at joints of limited movement. To improve the accuracy and precision of age estimation methods a great deal of emphasis has been placed on improving the methodological components. Revised methodologies have re-arranged the number of phases and scoring procedures for morphological traits, and have applied different statistical approaches including Bayesian and maximum likelihood inference. However, these revisions have contributed only slight improvements in the accuracy of age estimation. Tests of established age estimation methods have indicated that bone ageing rates may not be uniform across populations, and it has been suggested that such differences may be caused by the effects of genetic and environmental factors. Limited research has been performed to understand the causes of variability in rates of ageing, but the effects of body size, occupation, and levels of physical activity, parturition and the consumption of drugs and alcohol may be important. This symposium will present current research on the variability of skeletal ageing rates across populations with the aim of raising awareness among researchers of the importance of learning more about the skeletal ageing process. Three main themes will be communicated at the symposium: variability in rates of ageing across populations, factors that have an effect on bone ageing in

## THURSDAY MORNING SESSIONS

skeletal remains and living individuals, and the implications for methods of age estimation.

Discussant: Vanessa Campanacho.

Discussant: Andrew T. Chamberlain.

- 1 Macroscopic, microscopic and molecular biomarkers for age estimation: The role of environmental factors. A.T. CHAMBERLAIN.
- 2 Obesity affects the accuracy and precision of age at death estimations based on the pelvic joints. D.J. WESCOTT, S.R. MAVROUDAS.
- 3 Body size as a factor in skeletal age estimation: When size matters and how to deal with it. C.E. MERRITT.
- 4 The influence of body size in age estimation from the pelvic joints: methodological considerations. V. CAMPANACHO.
- 5 Aging using adult human pelvis morphology: effect of occupation or statistical method? M. MIRANKER.
- 6 The effects of osteoarthritis on age at death estimates from the human pelvis. S.E. CALCE, H.K. KURKI, D. WESTON, L. GOULD.
- 7 The relationship between pathology and age: diffuse idiopathic skeletal hyperostosis (DISH) in known-age individuals. L. CASTELLS NAVARRO, J. BUCKBERRY.
- 8 The Effect of Lifestyle Factors such as Smoking, Activity Level, and Pregnancy on Age Estimation from the Pubic Symphysis: A Study of 1,238 Living Volunteers. J. TRUESDELL.
- 9 Confounding factors: are molecular methods of age estimation less vulnerable? F. MAYER, T. ARENT, C. BOES, A. RECKERT, S. RITZ-TIMME.
- 4 Histological sectioning and imaging of *Papio* dentition prior to isotopic sampling permits fine-tuned assessments of ages at dietary transitions. M. MALONE, L. MACLATCHY, J. KINGSTON, G.T. SCHWARTZ.
- 5 Female sooty mangabeys (*Cercocebus atys*) select softer seeds than males. E. GEISSLER, D.J. DAEGLING, T.A. POLVADORE, W. MCGRAW.
- 6 Intraspecific Variation in a Food Mechanical Property: The Ecology of Fruit Hardness for a Primate Food at Gunung Palung National Park, Indonesia. B.J. FINKEL, A.J. MARSHALL.
- 7 Niche Partitioning, Diet, and Oral Processing Behaviors in Three Sympatric Guenons in the Taï National Park, Côte d'Ivoire. T.A. POLVADORE, E.E. KANE, M. WILKINS, F.M. GNEPA, D.J. DAEGLING, W. MCGRAW.
- 8 Near-infrared Spectroscopy as a Tool for Modeling Savanna Primate Diets. E.K. SMITH, J. LEICHLITER, M. SPONHEIMER, T. CERLING.
- 9 Variation in Sympatry Among Crowned Lemurs and Sanford's Lemurs: A Comparison Between Mt.d'Ambre National Park and Analabe Gallery Forest. B.Z. FREED, K.O. ARTHUR.
- 10 Isotopic Variability of Chimpanzee Vertebrate and Invertebrate Prey at Gombe National Park. R.S. NOCKERTS, R.C. O'MALLEY, M.L. WILSON, D.L. FOX.
- 11 Oral processing profiles of three sympatric colobines in Taï National Park, Côte d'Ivoire. J.N. TRAFF, M. WILLIAMS, E.E. KANE, D.J. DAEGLING, W. MCGRAW.
- 12 Unique Habitat Sharing between Humans and Wild Chimpanzees in Sierra Leone: Ecological Implications for the Human-Primate Interface. A.R. HALLORAN, C.E. BOLTEN.
- 13 Nutritional Balancing of Milk: Examining Nutritional Variability in Human Milk through a Geometric Framework. E.C. CANCELLIERE, K. HINDE, D. RAUBENHEIMER, J.M. ROTHMAN.
- 14 Correlates of energetic status among female chimpanzees at Ngogo, Kibale National Park using urinary C-peptide. S. GUNTER, K.B. POTTS, J.L. BROWN.
- 15 Great ape isotope ecology – moving beyond general patterns. V.M. OELZE.

### Session 11

#### Primate Nutrition/Foraging

##### Contributed Poster Presentations

Chair: Taylor A. Polvadore

Acadia

- 1 Nutrient limitation and orangutan facilitated nutrient recycling in a peat swamp habitat. S.E. ALAVI, S.S. UTAMI ATMOKO, M. DJINU, E.R. VOGEL.
- 2 Meat-eating in hamadryas baboons: temporal patterns of meat consumption and doum palm fruit availability. A.L. SCHREIER, R.M. SCHLAHT, L. SWEDELL.
- 3 Interannual variation in *Ptilocolobus badius badius* diet in Cote d'Ivoire's Tai National Park: implications for conservation. M. WILKINS, W. MCGRAW, E.E. KANE.

## THURSDAY MORNING SESSIONS

### Session 12

#### Primate Reproduction, Parentage, and Life History II

##### Contributed Poster Presentations

Chair: Magdalena N. Muchlinski

Acadia

- 1 Allocare in a captive population of hamadryas baboon (*Papio hamadryas*). A. CARTER.
- 2 Are Male Orangutans a Threat to Infants? Mother-offspring Interactions with Males in Wild *Pongo pygmaeus wurmbii*. A.M. SCOTT, C.D. KNOTT.
- 3 Correlates of fecal androgens in wild female white-faced capuchins (*Cebus capucinus imitator*). G. KING-BAILEY, K.M. JACK.
- 4 An ontogenetic perspective of the energetic constraints of brain growth on muscle mass. M.N. MUCHLINSKI.
- 5 Testosterone as a Predictor of Dispersal Strategies in Geladas. S. SEN, C. BARALE, J. BEEHNER.
- 6 Does the energetic status of wild orangutan mothers vary with infant age? T.D. BRANSFORD, M. EMERY THOMPSON, D.J. NAUMENKO, A.M. MOLDAWER, A.J. PRITCHARD, M.A. VAN NOORDWIJK, S. UTAMI ATMOKO, E.R. VOGEL.
- 7 High-stakes fighting: Monopolizability of females promotes intragroup killing in chimpanzees. M.L. WILSON, E.E. WROBLEWSKI, N.M. SIMMONS, D.C. MJUNGU, S.M. KAMENYA, R.S. RUDICELL, B.H. HAHN, A.E. PUSEY.
- 3 Make no bones without it: Characterization of region-specific behaviors in non-sutural cranial osteoblasts using bone morphogenetic proteins. J.A. BRILL, H.E. WEISS-BILKA, M.J. RAVOSA.
- 4 Investigating intra-skeletal variation in cortical bone strength parameters of the radius and tibia in non-osteoporotic males. R.L. HUNTER, K.C. BRILEY, A.J. YARD, M.M. MURACH, A.M. AGNEW.
- 5 An evaluation of US educator product priorities and challenges for teaching human evolution. B. POBINER, D. PATTERSON.
- 6 Comparison of body size changes among military personnel between 1988 and 2012. T.N. GARLIE, H. CHOI, J.L. PARHAM, J. BRANTLEY, S.P. PAQUETTE.
- 7 3D geometric morphometrics of lumbar vertebral curvatures in *H. sapiens*. S. LOIS ZLOLNISKI, D. GARCÍA MARTÍNEZ, E. BLANCO-PÉREZ, J.A. SANCHIS GIMENO, A. BARASH, S. MARTELLI, S. NALLA, M. BASTIR.
- 8 A theoretical demonstration for the effects of anthropometric secular changes relative to military accommodation rates among different race groups. H. CHOI, T.N. GARLIE, J. PARHAM, J. BRANTLEY, S.P. PAQUETTE.
- 9 Male infants, risk, and postnatal depression: Evidence regarding the Trivers-Willard hypothesis in a contemporary low-fertility context. S.E. JOHNS, S. MYERS.
- 10 Studying yellow fever virus susceptibility in humans using a howler monkey model. N. TOROSIN, K. FISCHER, J. ROUND, L.A. KNAPP.
- 11 Influence of anatomical, cognitive, and behavioral variables on the morphological variation of human corpus callosum. Y. HEUZÉ, N. TZOURIO-MAZOYER, E. MELLET, F. CRIVELLO.

### Session 13

#### Human Biology and Beyond

##### Contributed Poster Presentations

Chair: Victoria M. Dominguez

Acadia

- 1 Maternal Environment and Craniofacial Growth: Geometric Morphometric Analysis of Mandibular Shape Changes Associated with *In Utero* Overexposure to Thyroxine in Mice. M.J. KESTERKE, M.A. JUDD, M.P. MOONEY, M.I. SIEGEL, J. CRAY, M. ELSALANTY, R. HOWIE, S.M. WEINBERG.
- 2 Outreach initiatives related with health, obesity and osteology developed by the Anthropological Museum Montané in elementary schools and communities of Cuba. A. RANGEL, V. VÁZQUEZ, D. NIEBLA, M. DÍAZ.
- 12 Shape covariation of the human orbit and eyeball. A. RUEDELL.
- 13 Cortical Area vs Bone Area: Assessing Intracortical and Endosteal Bone Loss With Age. V.M. DOMINGUEZ, A.M. AGNEW.
- 14 The "other" drug: Implementing bird grasshoppers as a treatment for anemia. K.J. HURD.
- 15 Effects of ethanol on *Porphyromonas gingivalis* in planktonic and biofilm monocultures. N.A. SHORT, R.J. LAMONT, P.W. EWALD.
- 16 Timing and Duration of Epiphyseal Fusion and Implications for Growth Potential. M.E. BOEYER, R.J. SHERWOOD, C.B. DEROCHÉ, D.L. DUREN.
- 17 walkR: A Software Package to Analyze the Biomechanics of Human Locomotion. E.R. OTAROLA-CASTILLO, E.R. CASTILLO, M. HORA, M.G. TORQUATO, A.G. WARRENER, H. PONTZER.

## THURSDAY MORNING SESSIONS

- 18 "It Sucks To Be A Boy On His Period": Language Ideologies, "Women's" Health, & Trans\* Communities. A.E. GUITAR, S.M. PERRINO.
- 19 Variation in the Interface of Brain and Skull. S.Y. GREER, I.D. GEORGE, K. ALDRIDGE.
- 20 As Tall as Goliath? Stature Among the Philistines at Ashkelon. S.C. FOX, K. MARKLEIN, R. KALISHER, M. FAERMAN, P. SMITH, D. MASTER, A. AJA.
- 21 Membership in a LGBT-Focused Organization Serves as a Buffer against Stigma: A Biocultural Approach to Stigma Stress. N.D. ROY, C. WALKER, H. ACOSTA, S. LAWSON, C.D. LYNN.
- 22 The US ARMY Anthropometric Survey (ANSUR II): Database of body-size and associated demographic data of military personnel. J.L. PARHAM, T.N. GARLIE, H. CHOI, J. BRANTLEY, S.P. PAQUETTE.
- 9 An Analysis of Shape Differences in Crocodylian Dentition Using Geometric Morphometrics. P. FARRUGIA, J.K. NJAU, P. POLLY.
- 10 New Insights on the *Homo naledi* Ankle Using Three-dimensional Quantification. A. FERNANDEZ, W.E. HARCOURT-SMITH.
- 11 Can Small be All? The Limited Commonalities of Mata Menge and Liang Bua Hominins on Flores. M. HENNEBERG, A.J. KUPERAVAGE, S. CHAVANAVES, R.B. ECKHARDT.
- 12 *Homo naledi*'s pedal pathologies. Z. THROCKMORTON, B. ZIPFEL, P. RANDOLPH-QUINNEY, E. ODES, K. CONGDON, J. DESILVA, W. HARCOURT-SMITH, L. BERGER.
- 13 Minor Physical Anomalies as Additional Indicators of Developmental Disorder in LB1 from Liang Bua, Flores. R.B. ECKHARDT, S. CHAVANAVES, M. HENNEBERG.
- 14 Shifts in the distribution of rat body sizes through time at Liang Bua: New paleoecological insights into the extinction of *Homo floresiensis* and other endemic taxa. E.G. VEATCH, M.W. TOCHERI, T. SUTIKNA, JATMIKO, E.W. SAPTOMO, K.M. HELGEN.
- 15 Exploring the impact of collection strategies on interpretations of faunal abundance: a case study from the Koobi Fora Formation (Pleistocene, northern Kenya). A. ENNY, M. BIERNAT, D.R. BRAUN, W.H. REDA, A.S. HAMMOND, D.B. PATTERSON, W. BARR.
- 16 Problems in Predicting Anatomy and Inferring Behavior from the Gross Morphology of the Flexor Pollicis Longus Insertion Site. K.G. HATALA, E. WILLIAMS-HATALA, T. SCIBILIA, S. HILES, K.N. RABEY.
- 17 Revising the hypodigm of *Homo heidelbergensis*, a view from the Eastern Mediterranean. M. ROKSANDIC.
- 18 Electromyography, Kinematics, and Kinetics of the Upper Limb during Oldowan Stone Tool Manufacture. E.M. FEUERRIEGEL, M. HALAKI, D. REED, C.P. GROVES, K.A. GINN.
- 19 Mechanical Diet and its Role in Evolutionary Anthropology. H. SELVEY, O. PAINE.
- 20 The affinities of *Homo floresiensis* based on phylogenetic analyses of cranial, dental and postcranial characters. D. ARGUE, C. GROVES, M. LEE, W. JUNGERS.

### Session 14

#### Paleoanthropology: Early Homo II

##### Contributed Poster Presentations

Chair: Adam P. Van Arsdale

Acadia

- 1 Sex Differences in Walking Kinematics among Modern Humans. L.T. GRUSS, C. WALL-SCHEFFLER.
- 2 The biomechanics of stone tool behaviors and implications for the evolution of the human hand. E. WILLIAMS-HATALA, K.G. HATALA, M. GORDON, M. KASPER, T.L. KIVELL.
- 3 The diet of *Homo antecessor*. M. LOZANO, A. ROMERO, J. BERMÚDEZ DE CASTRO, E. CARBONELL, J. ARSUAGA, A. PÉREZ-PÉREZ.
- 4 Seasonal variation of  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in extant African suid enamel and its implications for fossil suid diets and paleoecology of hominin fossil sites. D. YANG, K.T. UNO.
- 5 The interaction of preservation bias and analytical bias in the fossil record. A.P. VAN ARSDALE.
- 6 Phosphate-water  $\delta^{18}\text{O}$  offset revision improves paleoclimatic reconstructions. D.R. GREEN, A.S. COLMAN.
- 7 Modeling Hominin Dispersal Patterns using Cost Path Analysis and Spectral Signature Models. R. MCPHERSON, C.M. MUSIBA.
- 8 A preliminary study of primate abundance in East Turkana collection areas relative to outcrop size. B. THOMPSON, J. ARENSON, M. BIERNAT, W. BARR, J. REEVES, D.R. BRAUN, A. HAMMOND.

## THURSDAY MORNING SESSIONS

### Session 15

#### Functional Anatomy: Jaws and Teeth

##### Contributed Poster Presentations

Chair: Kate McGrath

Acadia

- 1 The Developmental Cascade Biases Dates of Evolutionary Change in the Dentition. C.S. MONGLE, A. NESBITT, J.B. SMAERS, F.E. GRINE.
- 2 An Investigation of the Inhibitory Cascade Mechanism in Extant and Extinct Lemurs. K.K. CATLETT, L.R. GODFREY, K. SAMONDS, E. DALY, G.T. SCHWARTZ, A. EVANS.
- 3 What is a genus? Understanding craniodental diversity in *Callicebus*. L.B. HALENAR, S.B. COOKE.
- 4 First 3D dental topographic analysis of the enamel-dentine junction in non-primate euarchontans: investigating development, diet, and taxonomy. K.R. SELIG, M.T. SILCOX.
- 5 The Ontogeny of Masticatory Efficiency and Implications for Hominin Canine Reduction. H. GLOWACKA, G.T. SCHWARTZ.
- 6 Histological examination of molar development in Virunga mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda. S.C. MCFARLIN, D.J. REID, K. ARBENZ-SMITH, M.R. CRANFIELD, T.S. STOINSKI, T.G. BROMAGE, A. MUDAKIKWA.
- 7 Coordination of upper and lower primary postcanine tooth size in the haplorrhine primates by the inhibitory cascade. E. DALY, K.K. CATLETT, S. KING, K. SAMONDS, L.R. GODFREY, G.T. SCHWARTZ, A. EVANS.
- 8 The relationship between dental eruption sequence, phylogeny and life history in the evolution of primate dentition. T.A. MONSON, L.J. HLUSKO.
- 9 Quantifying linear enamel hypoplasia in Virunga mountain gorillas and other great apes. K. MCGRATH, S. EL ZAATARI, M.R. CRANFIELD, T.S. STOINSKI, A. MUDAKIKWA, T.G. BROMAGE, S.C. MCFARLIN.
- 10 Food toughness and dental microwear anisotropy. R.S. SCOTT, B.W. WRIGHT, K.A. WRIGHT, C. ROSS, A. VAN CASTEREN, M. FOGAÇA, D.M. FRAGASZY, C. MARCIL, D.S. STRAIT.
- 11 Many ways to form a pit, but not a scratch: modelling and measuring dental microwear signatures. M.A. BERTHAUME, E. SCHULZ-KORNAS, K. KUPCZIK.
- 12 Are developmental defects of enamel acquired according to seasonal schedules in Bornean gibbons and orangutans? An autocorrelation analysis. M. O'HARA, D. GUATELLI-STEINBERG.
- 13 Masticatory loading and diet type in relation to cross-sectional geometric properties of the primate zygomatic arch. H.M. EDMONDS.
- 14 The Biomechanical Consequences of Zygomatic Arch Shape. A.L. SMITH, I.R. GROSSE.
- 15 Effect of periodontal ligament on stress gradients in alveolar bone. A. RAPOFF, D. YANKOVA, W. MCGRAW, D. DAEGLING.
- 16 Subfamily affiliation conditions bone stiffness in Tai Forest monkeys. D.J. DAEGLING, J.D. PAMPUSH, W. MCGRAW.
- 17 Morphological Integration and Function in the Platyrrhine Mandible. M.A. HOLMES.
- 18 Scaling relationships within architectural properties of the jaw adductor musculature in *Macaca fascicularis*. E. DICKINSON, L.C. FITTON, K. KUPCZIK.
- 19 Analyzing the Morpho-functional Consequences of Seed Predation in the Pitheciid lower Jaw using Finite Element Analysis and Geometric Morphometrics. T.A. PÜSCHEL, J. MARCÉ-NOGUÉ, T.M. KAISER, R.J. BROCKLEHURST, W.I. SELLERS.
- 20 Trabecular symmetry in the primate temporomandibular joint. P.A. RAMOS, A.D. SYLVESTER, A.B. TAYLOR, C.E. TERHUNE.
- 21 Complex mandibular molar root size differences and similarities between non-human primate species (*Gorilla*, *Pongo* and *Pan*), and chimpanzee subspecies (*Pan troglodytes verus*). M. BÄUCHLE.

### Session 16

#### Human Skeletal Biology: Isotopes, Subsistence, and Mobility

##### Contributed Poster Presentations

Chair: Luseadra J. McKerracher

Acadia

- 1 Effects of Mounting Adhesives and Solvent Treatments on Sequential Sectioning of Dentine Samples for Stable Isotope Analysis (C, N). I. SCHARLOTTA.
- 2 The environmental sulfur isotope composition of the Maya region: A working model and preliminary results. A.J. RAND, V. GRIMES.

## THURSDAY MORNING SESSIONS

- 3 **Isotopes of Coastal Ecuador.** L. VAN VOORHIS, J. KRIGBAUM, V. MARTINEZ, N. JASTREMSKI.
- 4 **Stable isotope analyses of human bone collagen from Iron Age Switzerland - Diet and mobility of Swiss "Celtic" populations.** N. MOGHADDAM, F. MÜLLER, S. LÖSCH.
- 5 **Bone deep: stable nitrogen isotope ratios and histomorphometric measurements of bone remodelling within adult human skeletons.** G.E. FAHY, C.A. DETER, R. PITFIELD, P. MAHONEY.
- 6 **Inter-tooth differences in enamel defect and  $\delta^{18}\text{O}$  sequences: implications for research on individual high resolution stress histories.** C. WITZEL, A. SOŁTYSIK, E. KRZEMIŃSKA, Z. CZUPYT.
- 7 **Intermarriage and Hybridity at an Ancient Greek Colony: Oxygen Stable Isotope Analysis at Himera in Sicily.** V.C. ALARCIA, L.J. REITSEMA, B. KYLE, S. VASSALLO.
- 8 **Environmental background for a catastrophic event in an early urban centre in Syria: the evidence from oxygen isotopes and enamel defects.** A. SOŁTYSIK, C. WITZEL, H. SCHUTKOWSKI, E. KRZEMIŃSKA, Z. CZUPYT.
- 9 **Examining the pig in the poke: What happens with stable isotopes in the body tissues of livestock?** D.F. ANDERS, J.A. KRETZINGER, M.A. VOHBERGER.
- 10 **Early Colonial Period Exodus to the Southern Maya-Spanish Frontier: Investigating Immigration to Tipu through the use of Strontium and Oxygen Isotopes.** W.R. TRASK.
- 11 **Family isn't everything: Strontium and oxygen stable isotope analysis of a known population from Fewston Parish, UK.** L. QUADE, R. GOWLAND, A. MILLARD.
- 12 **From whence they came: Identifying natal landscapes using strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) signatures in late prehistoric southwestern Portugal.** A.J. WATERMAN, E. WRIGHT, M. KUNST, J. CARDOSO, D.W. PEATE.
- 13 **Isotopic perspectives on human mobility at the Imperial Roman Rue Jacques Brel necropolis (ca. 1st to 3rd c. CE) in Saintes, France.** R.J. STARK, T.L. PROWSE.
- 14 **Assembling a Winning Army: Strontium Isotope Analysis of Local and Non-Local Soldiers from the Ancient Greek Battles of Himera (480 BCE, 409 BCE).** J.R. STAMER, K.L. REINBERGER, B. KYLE, P. FABBRI, S. VASSALLO, L.J. REITSEMA.
- 15 **Baseline characterization and biogeochemical variation for the identification of paleomobility in the Aegean.** E. PREVEDOROU, J.E. BUIKSTRA, G.W. GORDON, K.J. KNUDSON.
- 16 **Anthropological evidence of multi-ethnicity in the first Greek settlement in Italy. Strontium isotopic analysis of the skeletal sample from the necropolis of Pithekoussai, (Ischia VIII cent. BCE - III cent. CE).** M. GIGANTE, V. WARTER, W. MÜLLER, A. SPERDUTI, L. BONDIOLI.
- 17 **Using Stable Isotopes to Assess Dietary Variation in Late Middle Woodland Settlements in the Central United States: Evidence from Human Burials at Monkey Mountain (23J014) Warrensburg, Missouri.** H.E. MARSH, A.J. WATERMAN, R.H. TYKOT.
- 18 **Bread and Porridge in Early Berlin: A Palaeodietary Analysis of the Medieval Cemetery at Petriplatz, Germany.** M.E. ZECHINI, K. KILLGROVE, J. HOLMSTROM, B.J. SCHAEFER, B.L. TURNER.
- 19 **Stable Isotope Analysis of Human Diet at the Santa Bárbara Mining Encampment.** T.K. PROCTOR, D.K. SMIT, T.A. TUNG.
- 20 **Reconstructing Székely Subsistence: Stable Isotope Evidence for Medieval Diet in Eastern Transylvania.** E.M. PESCHEL, T.E. DUNN, J.D. BETHARD, Z. NYARADI, A. GONCIAR, M. KATZENBERG, S.H. AMBROSE.
- 21 **Temporal trends in medieval diet at Stoke Quay, Ipswich, England.** E. FARBER, A. ROSE, J. LEE-THORP, L. LOE, H. HAMEROW.
- 22 **Stable Carbon and Oxygen Isotope Analysis of Archaeological Dental Calculus: Potential for Future Study.** S.D. PRICE, H.P. SCHWARCZ, A. KEENLEYSIDE.
- 23 **Stable carbon and nitrogen isotopes of dental calculus from Greenlandic Inuit are consistent with a protein-rich and fat-rich diet.** G. SCOTT, S.R. POULSON, N. LYNNERUP.
- 24 **The Complexities and Interpretive Benefits of Employing Local Food Resources for Dietary Reconstruction via Stable Isotope Analysis.** S.C. DENT, D.L. HUTCHINSON.
- 25 **Micro-fossils Recovered from Dental Calculus: Implications for Reconstructing Moche Diet.** C.M. GAGNON, A.O. LAFFEY.
- 26 **The Metagenomic Analysis of Oral Microbiome Composition of Dental Calculus Recovered from Institutionalized Individuals from the Mississippi State Asylum, Jackson MS.** J.R. BELANICH, H.R. JORDAN, M.K. ZUCKERMAN, N.P. HERRMANN, S. MILLER, J. ROSCH.
- 27 **Diet and Social Complexity in the Atacama Desert of Northern Chile (AD 700 – 1100).** R.M. SCOTT, S.E. HALCROW, V. STANDEN, B. ARRIAZA, C.W. SCHMIDT.

## THURSDAY MORNING SESSIONS

- 28 Human diet in the early medieval period: Tooth wear, mastication, enamel thickness and its relationship to social stratification. A. IBROVÁ, J. DUPEJ, P. STRÁNSKÁ, P. VELEMÍNSKÝ, L. POLÁČEK, J. VELEMÍNSKÁ.
- 29 Environment resources use of Rio De Janeiro's state coast by shellmound builders: an estimate of diet composition. V. GUIDA, M. BASTOS, S. REIS, C. RODRIGUES-CARVALHO.
- 30 Isotopic and paleopathological analysis of Pre-Columbian secondary interments at Cueva Vigía, Sancti Spiritus, Cuba. M. HERNANDEZ, A. RANGEL RIVERO, D. MACHADO MENDOZA.
- 31 The Importance of Shoes: Correlation between Grave Goods, Status, and Diet of Late Iron Age and Early Roman Individuals from Winterborne Kingston, UK. S.A. MCGUIRE, H. SCHUTKOWSKI, M. HUBBE.
- 32 Age, body size, and reproductive status affect  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values: Evidence from living Maya women from Guatemala. L.J. MCKERRACHER, M. COLLARD, P. NEPOMNASCHY, M.P. RICHARDS.
- 33 Gender differences in diet and physical activity: Evidence of social difference in a Muisca community (Sabana de Bogotá, Colombia, 1000-1400 AD). M.J. MILLER, S.C. AGARWAL, C.H. LANGEBAEK.
- 34 A Bioarchaeological Investigation of Marine Resource Procurement among the Chumash of Santa Rosa Island, California. S.C. KUZMINSKY, J.M. ERLANDSON, T. XIFARA.
- 35 Adult and early childhood diet of early medieval untypical population group of Central Europe (10th century AD, Czech Republic) in relation to the health status. S. KAUPOVA, P. VELEMINSKY, P. STRANSKA, K. TOMKOVA.
- 36 Diet Reconstruction of the Ancient People from Chinese Silk Road: The Tooth Wear of the Bronze-Iron Age Population From Jiayi Cemetery in Xinjiang, China. W. ZHANG, H. ZHAO, S. YANG, A. WANG, X. MAN, N. LIANG, X. GAO.
- 37 An Isotopic Approach to Examining Culture Change at Casas Grandes, Mexico. A.M. OFFENBECKER, K.D. WALLER, J.H. KELLEY, M. KATZENBERG.
- 38 Revealing variation in social integration: Diet and migration at the ceremonial site of La Marcha, Peru in the southern Nasca region (1-1000 BCE). C.M. KELLNER, V. WHALEN, A. FIGUEROA FLORES.
- 39 Dietary variability and age-related behavioural changes among hunter-gatherers from Roonka, South Australia. C.B. SMITH, J. LITTLETON.
- 40 Horse Trail Shelter (41VV166): Understanding subsistence and lifeways in the Lower Pecos Canyonlands of Texas during the Late Prehistoric using a novel SfM approach to osteological data collection. C.C. SIEGERT, C.W. KOENIG, A.M. CASTANEDA, S.L. BLACK, M.D. HAMILTON, L.A. MECKEL, D.S. GLEIBER, S.R. MAVROUDAS.
- 41 *In Cibus Veritas*: Palaeodietary Analysis of Skeletons from 5th Century BC, Italy. A.N. ACOSTA, K. KILLGROVE, B.L. TURNER, B.J. SCHAEFER.
- 42 Isotope paleodietary investigations on a Medieval Christian population from the 4th Cataract of the Nile River in Sudan. D. ANTOINE, M.A. MANNINO, M.P. RICHARDS.
- 43 A Multi-Isotopic Approach to the Reconstruction of Prehistoric Mobility and Burial Patterns in the Iranian plateau during Bronze Age. F. KHATIBI JAFARI.

# THURSDAY, EVENING SESSIONS

## Session 17

### Collaborations Across Anthropology and Genetics: Examples of Transdisciplinary Work

#### Invited Podium Symposium

Organizers/Chairs: *Connie J. Mulligan, Catherine Panter-Brick*

Bissonet

Working across disciplines often helps us tackle new research issues and achieve better insights into questions which range from human health over the lifecourse to questions of human identity and evolution. How do geneticists, human biologists, medical anthropologists, psychologists, and archaeologists initiate collaborations, manage the integration of different types of data, and coordinate approaches to ask novel research questions? What do researchers gain from collaboration in terms of data capture, analytical strategy, and insights about what matters for individuals and populations in specific environments? Oftentimes inter-disciplinary collaborations lead to the formulation of new research questions, an overhaul of data collection and analytical strategies, and a more careful use of concepts such as race, resilience, and genetic inheritance. This symposium, sponsored by the American Association of Anthropological Genetics, showcases concrete examples of collaborative work which invites reflection on the value of transdisciplinary research.

- 2:30 **Genetics of risk and resilience in Syrian refugee youth.** C.J. MULLIGAN, C. CLUKAY, J. QUINLAN, R. DAJANI, D. HAMADMAD, G. ABUDAYYEH, C. PANTER-BRICK.
- 2:45 **Epigenetic pathways of intergenerational phenotypic inertia in birth weight: Evidence from mothers in Cebu, Philippines.** C.P. RYAN, M.J. JONES, J.L. MACISAAC, A. MORIN, J.B. BORJA, M.S. KOBOR, C.W. KUZAWA, T.W. MCDADE.
- 3:00 **Posttraumatic stress and psychological resilience in Nepali child soldiers: an interdisciplinary study in human social genomics.** C.M. WORTHMAN, B.A. KOHRT, S.W. COLE.
- 3:15 **Can acupuncture decrease stress and increase telomerase activity to promote healthy cellular aging among older adults with depression or anxiety?** A.L. NON, E.S. CLAUSING, L.S. REDWINE, N.C. RODNEY.
- 3:30 **Physiology, fertility, and population genetics.** C.M. BEALL, A. DI RIENZO.
- 3:45 **A Bio-Ethnography of Environmental Health and Body Mass in Mexico City: Challenges and Preliminary Results.** E.F. ROBERTS, M. TÉLLEZ-ROJO.
- 4:00 **Structural Racism, Genetic Variation, and Hypertension among African Americans: Evidence from HEAT Heart Health.** C.C. GRAVLEE, J. QUINLAN, R. VACCA, C. MCCARTY, P. BOSTON, M. MITCHELL, C.J. MULLIGAN.
- 4:15 **The "Environment" in Gene-Environment Interaction Research: An Anthropological View.** W.W. DRESSLER.
- 4:30 **Break.**
- 4:45 **Genetic Ancestry, Race, and National Belonging in Argentina: Interdisciplinary Investigations.** G.S. CABANA, M. MENDOZA, L. SMITH.
- 5:00 **Ancient TB in the Americas: the partnership between bioarchaeology and genetics to identify a killer.** A.C. STONE, T. HONAP, Å.J. VÅGENE, J.E. BUIKSTRA, A. HERBIG, K.I. BOS, J. KRAUSE.
- 5:15 **Unstated Assumptions and Interdisciplinarity in the Study of Ancient Pathogen DNA.** J.E. BUIKSTRA.
- 5:30 **Discussant: Catherine Panter-Brick.**

## Session 18

### Primate Nutrition and Foraging

#### Contributed Podium Presentations

Chair: *Margaret J. Schoeninger*

Balcony I/J

- 2:30 **The gut microbiome and metabolome of saddle-back tamarins (*Leontocebus weddelli*): Understanding the foraging ecology of a small-bodied primate.** P.A. GARBER, A. GOMEZ.
- 2:45 **The role of primate entomophagy in niche partitioning and species coexistence: a molecular case study from Kibale National Park (KNP), Uganda.** M.M. LYKE, A. DI FIORE, N. FIERER, A.A. MADDEN, J.E. LAMBERT.
- 3:00 **Who, What, Where: Patterns of Gut Microbial Diversity in Atelines.** K.M. MILICH, K.R. AMATO, A. LINK, A. DI FIORE.
- 3:15 **Orangutans, Fruit, and the Geometric Framework - Fruit and Non-Fruit Choice in Wild *Pongo pygmaeus wurmbii*.** A.L. DIGIORGIO, C.D. KNOTT.
- 3:30 **Stable Isotope Ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of Hair Indicate Habitat Ecology and Diet at Two Chimpanzee Study Sites.** M.J. SCHOENINGER, C.A. MOST, J.J. MOORE, A.D. SOMERVILLE.
- 3:45 **The Multidimensional Nutritional Niche of Baboons.** C.A. JOHNSON, D. RAUBENHEIMER, J.M. ROTHMAN.

## THURSDAY EVENING SESSIONS

- 4:00 Elemental Ratios of Carbon and Nitrogen Track Weaning in a Graminivorous Primate (*Theropithecus gelada*). L.J. REITSEMA, N. SNYDER-MACKLER, J.C. BEEHNER, T.J. BERGMAN, A. LU.
- 4:15 Nutritional balancing among Angola black and white colobus monkeys (*Colobus angolensis palliatus*) in structurally distinct areas of the Diani Forest, Kenya. N.T. DUNHAM.
- 4:30 Break.
- 5:00 Diana monkeys (*Cercopithecus diana*) experience fewer mechanical challenges during periods of low fruit availability. E.E. KANE, A. VAN CASTEREN, M. WILKINS, J.N. TRAFF, S.E. LAD, D.J. DAEGLING, W. MCGRAW.
- 5:15 From forest to savannah: exploring the mechanical properties of eastern chimpanzee (*Pan troglodytes schweinfurthii*) foods. A. VAN CASTEREN, K. KUPCZIK.
- 5:30 Foraging Efficiency and Ecological Risk Aversion in Juvenile Bornean Orangutans. C.D. KNOTT, K.E. DELONG.
- 5:45 Nutritional strategies of female redbelt monkeys (*Cercopithecus ascanius*). M.A. BRYER, D. RAUBENHEIMER, J.M. ROTHMAN.
- 6:00 The power of protein: protein regulation, energetics, and health in wild Bornean orangutan (*Pongo pygmaeus wurmbii*). E.R. VOGEL, T.D. BRANSFORD, S.E. ALAVI, M. EMERY THOMPSON, B.E. CROWLEY, W.M. ERB, M.A. VAN NOORDWIJK, S. UTAMI ATMOKO, D. RAUBENHEIMER, J.M. ROTHMAN.
- 6:15 Dietary abrasiveness and chewing efficiency in chimpanzees. E. SCHULZ-KORNAS, J. STUHLTRAEGER, R. WITTIG, K. KUPCZIK.
- 3:15 Ancestral state reconstructions of dental development in Miocene fossil taxa. C. KUFELDT.
- 3:30 New fossil primates from the Lower Siwaliks of India. C.C. GILBERT, B.A. PATEL, N.P. SINGH, C.J. CAMPISANO, J.G. FLEAGLE, K.L. RUST, K.D. PUGH, R. PATNAIK.
- 3:45 New Small Catarrhine Fossils from Songhor and Lower Kapurtay and their Implications for Interpreting Early Miocene Primate Communities. R.J. JANSMA, I.O. NENGO, K.P. MCNULTY, S. COTE, N. MALIT, N.J. STEVENS.
- 4:00 Yet another new cranium from the early Miocene: the most complete male cranial remains of the fossil ape *Ekembo*. S. MUTETI, T. LEHMANN, L. MICHEL, S. COTE, D.J. PEPPE, R.J. JANSMA, K.P. MCNULTY.
- 4:15 Geochronology and palaeoecological implications of new orangutan-bearing fossil deposits from the Padang Highlands, western Sumatra. J. LOUYS, G.J. PRICE, J. ZAIM, Y. RIZAL, W.D. SANTOSO, A. TRIHASCARYO.
- 4:30 Break.
- 5:00 The unusual and generically distinct face of the middle Miocene small-bodied ape "*Micropithecus*" *leakeyorum* from Maboko Island, Kenya. B.R. BENEFIT, M.L. MCCROSSIN, E. DAVIS.
- 5:15 Signals of Ecogeography and Phylogeny in the Macaque Dentition (*Cercopithecidae: Macaca*). N.D. GRUNSTRA, R.A. FOLEY, P. MITTEROECKER.
- 5:30 Long bone cross-sectional diaphyseal shape follows different ontogenetic trajectories in captive and wild gorillas. S.L. CANINGTON, A.D. SYLVESTER, M. BURGESS, J. JUNNO, C.B. RUFF.
- 5:45 Revisiting the Early Miocene Paleoenvironments of Rusinga Island, Lake Victoria, Kenya based on Paleosols and Paleontological Analyses. L.A. MICHEL, K.P. MCNULTY, T. LEHMANN, A. NOVELLO, S.G. DRIESE, D.L. FOX, N.D. GARRETT, D.J. PEPPE.
- 6:00 Shift in Dental Topography and Size in the Early Euprimate *Teilhardina* in Response to Climate Change at the End of the Paleocene-Eocene Thermal Maximum. P.E. MORSE, D.M. BOYER, J.I. BLOCH.
- 6:15 Revised geochronology of the Early Miocene faunas from Rusinga Island and Mfangano Island (Lake Victoria, Kenya): Implications for Miocene hominoid evolution and faunal succession. D.J. PEPPE, A.L. DEINO, K.P. MCNULTY, M.S. MCCOLLUM, A.L. MITCHELL, S.G. DRIESE, H.M. DUNSWORTH, D.L. FOX, W.E. HARCOURT-SMITH, K. JENKINS, T. LEHMANN, L.A. MICHEL.

### Session 19

#### Primates and Evolution

##### Contributed Podium Presentations

Chair: Ulrich H. Reichard

Studio 1/2/3

- 2:30 Evolution of Gibbons and Siamang: What do we know? U.H. REICHARD, M.M. CROISSIER.
- 2:45 Rethinking Neonatal Brain Size: Birth Timing Relative to Brain Growth and Neurodevelopmental Schedules in Primates and other Mammals. A.C. HALLEY, T.W. DEACON.
- 3:00 The effect of different patterns of cranial vasculature on encephalization within Primates. A.R. HARRINGTON, D.M. BOYER.

## THURSDAY EVENING SESSIONS

- 6:30 Does Size Matter? Using Size Variation to Diagnose the Presence of Multiple Species in Subfossil Lemur Samples. A.J. ZAMORA, J.P. HERRERA.
- 6:45 Dispersal of early haplorhine primates by rafting across Tethys: Discovery of an Eocene omomyid from northern Anatolia. K. BEARD, G. MÉTAIS, A. LICHT, P. COSTER, F. OCAKOĞLU, J. KAPPELMAN, M.H. TAYLOR.

### Session 20

#### Human Skeletal Biology: Life Experience, Violence, and Disease

##### Contributed Podium Presentations

Chair: *Emily A. Sharp*

Studio 7/8/9

- 2:30 Radiological and Forensic Re-evaluation of the Cause of Death of the Iceman, c. 5300 BP. F. RUHLI, P. PERNTNER, O. PESCHEL.
- 2:45 Get rid of the ugly one: congenital deformations and early childhood pathologies in the female monastic population in the Iberian Peninsula. N. ŠARKIĆ, R. DINARÈS, L. MUÑOZ, J. HERRERÍN.
- 3:00 Delineating the effects of early life experience on adult immune function in 20th Century Portugal. K.E. BLEVINS, C. ROBERTS, A. SANTOS.
- 3:15 Treponemal Disease in Early China. K. PECHENKINA, S. CHEN, W. FAN.
- 3:30 Palatal Destructive Lesions in the St. Jørgen's Medieval Leprosarium: Paleopathological Analysis and Paleoepidemiological Inferences. V.M. MATOS, C. MARQUES.
- 3:45 Molecular evidence for *Plasmodium falciparum* malaria in 1st-4th c. A.D. southern Italy. S. MARCINIAK, T.L. PROWSE, A. HERRING, J. KLUNK, M. KUCH, A.T. DUGGAN, L. BONDIOLI, E.C. HOLMES, H.N. POINAR.
- 4:00 Utilizing non-weight-bearing bones in archaeological investigations of the evolution of osteoporosis. R. MOUNTAIN.
- 4:15 Hale and Frail: Skeletal Frailty in Medieval and Postmedieval London. D.E. CREWS, K.E. MARKLEIN.
- 4:30 Break.
- 5:00 Long bone growth in a mid-19th century documented sample of the urban poor from Bethnal Green, London, UK. R. IVES, L.T. HUMPHREY.

- 5:15 Can the Timing of Deciduous Tooth Emergence be Partially Accounted for by Mother's Past or Current Circumstances? J.E. SPENCE, B. FLOYD, D. GUATELLI-STEINBERG, B. PIPERATA.
- 5:30 Trauma, Stress, and Sociopolitical Change in the Lower Río Verde, Oaxaca, Mexico. A.T. MAYES, A. JOYCE, S. BARBER.
- 5:45 Interpersonal violence during the Andean Early Intermediate Period and Middle Horizon. E.A. SHARP, R.E. BRIA.
- 6:00 A Pact of Not Forgetting: Understanding Medellín's Violent Past Through a Modern Documented Skeletal Collection. J.E. ROTHWELL.
- 6:15 Number of battle deaths scale with population size rather than differential proclivities for violence among humans living in nonstate and state societies. D. FALK, C. HILDEBOLT.
- 6:30 The costs of conquest: Detecting changing environmental stress in the transition from Iron Age to Roman England. A.R. TOBIN, C.A. ROBERTS.

### Session 21

#### Diversity, Variation, and Paleoecology: A View of Hominin Complexity from the Middle Pliocene of Eastern Africa

##### Invited Poster Symposium

Organizers/Chairs: *Amy L. Rector, Denise F. Su, Kaye E. Reed*  
Balcony K

Hominin fossil discoveries in the last two decades have dramatically increased the taxonomic diversity of hominin species from the middle Pliocene (~4-3 Ma) of eastern Africa. Detailed morphological, geological, and paleoecological studies show that this increase in diversity is not limited to taxonomic representation, but also to habitat, diet, and locomotion. This symposium brings together experts in hominins, paleoecology, and geology to synthesize the data from the last twenty years and examine the implications for our understanding of early hominin evolution.

- 2:30 Individual poster presentations (Odd posters).
- 3:30 Individual poster presentations (Even posters).
- 6:00 Discussants: William Kimbel and Carol Ward.
- 1 Hominin Adaptation and Variation within a Paleoecological Context: An Integrative Approach. A.L. RECTOR, K.E. REED, D. SU.

## THURSDAY EVENING SESSIONS

- 2 **A Stable Oxygen Isotope Mosaic Index: Implications for Reconstructing Hominin Paleoenvironments in East Africa.** M.M. BEASLEY, M.J. SCHOENINGER.
- 3 **Warm pools, upwellings, and an early glacial. Are “mid-Pliocene” climate transitions reflected in the eastern African records?** C.J. CAMPISANO, K.E. REED.
- 4 **Biogeography, Endemism, and Functional Trait Community Structure: Basinal Differences in the Pliocene.** K.E. REED, I.E. SMAIL, J. ROWAN, J. ROBINSON, E.M. LOCKE, I.A. LAZAGABASTER, C.J. CAMPISANO.
- 5 **Pliocene African Cercopithecoid Evolution, Turnover and Diversity.** S.R. FROST.
- 6 **Diversity, Abundance, and Paleoecology of East African Suidae in the Context of Hominin Evolution During the Pliocene.** I.A. LAZAGABASTER, J.R. ROBINSON, C.J. CAMPISANO, K.E. REED.
- 7 ***Australopithecus afarensis* habitat diversity: a unique perspective from Laetoli, Tanzania.** D.F. SU, T. HARRISON.
- 8 **Paleoenvironments and Dietary Adaptation of *Australopithecus afarensis*: A Synthesis.** Z. ALEMSEGED, J.G. WYNN, W.H. KIMBEL.
- 9 **Comparing the habitats of 3.5–3.2-million-year-old hominins at Woranso-Mille and Hadar, Ethiopia.** Y. HAILE-SELASSIE.
- 10 **Plio-Pleistocene hominid diversity interpreted through the genetic mechanisms that pattern the dentition.** M.F. BRASIL, T.A. MONSON, C.A. SCHMITT, L.J. HLUSKO.
- 11 **Evaluating the utility of extant reference samples for modelling hominin taxonomic variation.** J. PLAVCAN.
- 12 **Defining *Homo* or identifying *Homo*? The role of the genus in hominin taxonomy.** B.A. VILMOARE.

### Session 22

#### **Foreign Affairs: Bioarchaeological Approaches to Ethnicity, Identity, and Interaction in The MENA Region**

##### **Invited Poster Symposium**

*Organizers/Chairs: Margaret A. Judd, Lesley A. Gregoricka*

Studio 4/5

Bioarchaeologists working in the Middle East and North Africa (MENA) often face challenges unique to the discipline, from extensive commingling and fragmentation to poor preservation resulting from hyper-arid climates. As a result, the skeletal remains from this region have been understudied despite their rich potential in revealing past human behaviors. Questions of identity and ethnicity are especially critical to contextualizing

adaptation, interaction, and mobility - both within and between human groups. Bioarchaeologists are uniquely suited to address such inquiries owing to interpretive frameworks that encompass not only biological assessment of skeletal material but that also link funerary archaeology, material culture, historical documents, and social theory. Such a holistic approach facilitates a more nuanced understanding of the ways in which communities and agents throughout this region maintained and negotiated their own identities and ethnicities amidst changing forms of both internal social organization and external political and/or economic influences. Moreover, given current events in MENA that threaten the lives, livelihoods, and histories of so many ethnic groups and communities today - from the refugee crisis to the destruction of cultural heritage - it is important for bioarchaeologists to pursue questions of identity in the region. The goal of this session is to bring together scholars working throughout the MENA region to more critically evaluate how identity, ethnicity, and past interaction might be re-approached using current methodologies and multiple lines of evidence coupled with explanatory theoretical models.

3:00 Individual poster presentations.

4:00 Discussant: Megan Perry.

- 1 **Lineage and Lifestyle in Early Bronze Age Jordan: A Biogeochemical Investigation of Charnel House Human Remains.** L.A. GREGORICKA, S.G. SHERIDAN.
- 2 **The monastic mosaic at Mount Nebo, Jordan.** M.A. JUDD, L.A. GREGORICKA, D. FORAN.
- 3 **States of Being: Exploring Nabataean *Nationality*.** J. WALKER.
- 4 **Between Land and Sea - Bioarchaeological Dynamics at Middle Bronze Age Sidon, Lebanon.** H. SCHUTKOWSKI, N. SPEITH.
- 5 **Bodies in Motion: Migration and Identity in Bronze Age Cyprus.** A.J. OSTERHOLTZ.
- 6 **Manipulation of the dead: exploring delayed burial practices at Neolithic Çatalhöyük.** E.M. SCHOTSMANS, S.D. HADDOW, M.A. PILLOUD, M. MILELLA, B. GLENCROSS, B.J. BETZ, C.J. KNÜSEL.
- 7 **Building Communities: Strontium isotope and cross-sectional geometry analysis in early sedentary communities.** J.A. PEARSON, D. BAIRD, J. EVANS, E. GAROFALO, C.B. RUFF, S.D. HADDOW, C.J. KNÜSEL, C.S. LARSEN.

## THURSDAY EVENING SESSIONS

- 8 **Mobility in Neolithic Central Anatolia: A Comparison of Dental Morphometrics and aDNA.** M.A. PILLOUD, M. SOMEL, S.D. HADDOW, C.J. KNÜSEL, C. LARSEN, M. ÖZBAŞARAN, O. ERDAL, D. BAIRD, J. PEARSON, A. GÖTHERSTRÖM, J. STORÅ, M. JAKOBSSON, G. KILINÇ, F. ÖZER, D. KOPTEKIN, N. DAĞTAŞ.
- 9 **Class and Continuity in a Roman/Parthian Period cemetery at Tall Šēh Ḥamad, Syria.** J.G. KENNEDY, D. MERRIWETHER.
- 10 **Commingle, Disarticulated, and Eroded... Oh My! Navigating Bioarchaeology in the Arabian Peninsula.** A.C. CAINE.
- 11 **Two Potential Cases of Eunuchism from a Ptolemaic-Roman Cemetery in the Western Delta of Egypt: Differential Diagnosis and Social Implications.** S.D. HADDOW, S. ZAKRZEWSKI, J. ROWLAND.
- 12 **Preservation poor—data rich: bioarchaeology of the Neolithic peoples from Gebel Ramlah, Western Desert, Egypt.** J.D. IRISH, A. CZEKAJ-ZASTAWNY, J. KABACIŃSKI.
- 13 **Kin structure of the Amarna South Tombs Cemetery.** W.C. SCHAFFER, C.M. STOJANOWSKI, J.C. ROSE, J.E. BUIKSTRA.
- 14 **Morphological Changes and Expansion in New Kingdom Egypt and the Levant.** K.E. SANDERS.
- 15 **Mortuary Patterns and Health in New Kingdom Juvenile Burials from Tombos.** K.M. WHITMORE, M.R. BUZON, S.T. SMITH.
- 16 **Tooth Avulsion, Identity and Funerary Archaeology at Al Khiday 2, Central Sudan.** T. JAKOB, J.W. WALSER III, D. USAI, S. SALVATORI.
- 17 **Foreign Exchange in the Fourth Cataract Region of Ancient Nubia.** B.J. BAKER.

### Session 23

#### **The Anthropology of Islands: Evolution, Variation, and New Research Directions**

##### **Invited Poster Symposium**

*Organizers/Chairs: Colleen B. Young, Lu Yao*

Studio 6

Islands are excellent laboratories to study how ecological factors affect species size, shape, and development. Organisms' historical bauplans are shaped into functional phenotypes within island ecosystems. Darwin (1859) observed this process in the adaptive radiation of finches on the Galapagos. While island evolution and ecology are regularly used to understand organismal diversity in non-human biological disciplines, fewer anthropologists have subscribed to this lens for understanding primate diversity. Understanding how island evolution and

ecology applies to primates is important for several reasons: over half of all primate taxa on earth inhabit islands, unique island fossils (such as specimens associated with *Oreopithecus* and *Homo floresiensis*) have perplexed paleoanthropologists for years, and humans on islands exhibit extraordinary adaptations in isolated environments. Further, recent climate change and biodiversity crises necessitate more research on how primates survive in stressful environments along with environments that restrict migration, two factors which can accelerate and exaggerate evolutionary processes. The purpose of this symposium is to highlight the importance of current research about insular organisms in order to better understand primates that inhabit island ecosystems. A wide range of presenters have been asked to present their research that encompasses pertinent island topics ranging from: paleontology, genetics, archaeology, primatology, and ecology. Presenters will highlight how their island research is important for understanding primate evolution and diversity. Further, they will make suggestions for future research that will deepen our understanding of island theory and its applications to hominins.

5:00 Discussant: Agustin Fuentes.

- 1 **Face in the Sand: Island Rules, Biogeography, and the Fallacy of Palauan Hobbits.** J.H. STONE, S.M. FITZPATRICK.
- 2 **High brachial and crural indices in Island Foxes: analysis of island fox and human populations and applications for understanding the pygmy body type.** C.B. YOUNG, L.W. COWGILL.
- 3 **External Auditory Exostoses and their Relationship to Aquatic Activities on Santa Cruz and San Miguel Islands, California.** B.M. LUCERO.
- 4 **Multivariate craniodental allometry in tarsiers (*Tarsius*), a small-bodied, cryptic, insular primate.** R.A. MUNDS, G.E. BLOMQUIST.
- 5 **Dietary Differences of Two Sympatric Folivorous Indriids as a Mechanism for Niche Separation in a Highly Seasonal Island Environment.** L.K. OLIVER.
- 6 **Life on the "Ultimate Island": The Adaptive Radiation of the Sulawesi Macaques and their Shared Ecologies with Humans.** E.P. RILEY.
- 7 **Evolution of brain size in *Macaca fascicularis* on Southeast Asian islands.** R.D. MARTIN, L. YAO.

## THURSDAY EVENING SESSIONS

### Session 24

#### Primate Ecology and Conservation

##### Contributed Poster Presentations

Chair: Irene E. Smail

Acadia

- 1 The Number of Male and Female *Simias concolor* on the Pagai Islands, West Sumatra, Indonesia. L.M. PACIULLI, A. SHARMA, K. ALTABET.
- 2 Does National Park Protection influence Mammal Presence?: Comparing Chimpanzee's Competitors, Predators, and Prey between Niokolo-Koba National Park and Fongoli Savanna Research Site in Senegal. S.L. BOGART, M. GUEYE, P. NDIAYE, J.D. PRUETZ, S.M. LINDSHIELD.
- 3 Comparison of the oral, rectal, vaginal, and penile microbiome in semi-free ranging Eastern Chimpanzees (*Pan troglodytes schweinfurthii*). A.E. ASANGBA, L. MUGISHA, K.E. NELSON, S.R. LEIGH, B.A. WILSON, B.A. WHITE, R.M. STUMPF.
- 4 Behavior of Red Uakaris in a Heterogeneous Landscape in Northeastern Peru. R.M. HORES, S.M. FORD.
- 5 Homerange and sleeping site use by the Critically Endangered Cat Ba langur (*Trachypithecus poliocephalus*). R.L. HENDERSHOTT, A.M. BEHIE, B.M. RAWSON.
- 6 Cathemerality in Crowned Lemurs and Sanford's Lemurs: Evidence From Analabe Gallery Forest in Northern Madagascar. K. ARTHUR, B. FREED.
- 7 Mixed Effects of Modern Climate, Pleistocene Climate, and Anthropogenic Activity on Global Primate Diversity Patterns. J.J. ROWAN, I.E. SMAIL, K.E. REED.
- 8 The Effect of Forest Disturbance on the Feeding Ecology and Behavior of *Varecia variegata* in Ranomafana National Park. M. DONOHUE, P.C. WRIGHT.
- 9 Meet me at the airstrip: Fission-fusion dynamics and ranging patterns in a kinda-chacma hybrid baboon group. M.M. MCDONALD.
- 10 Primate Health Responses to Extreme Drought in Northwestern Costa Rica. K.M. JACK, S.A. CORTESE, G.L. KING-BAILEY, M. BERGSTROM, L.M. FEDIGAN.
- 11 Seed Dispersal Effectiveness in Two Populations of Bornean Orangutans (*Pongo pygmaeus wurmbii*). A. BLACKBURN, S.E. ALAVI, P. LADY, . RIYANDI, E.R. VOGEL, C.D. KNOTT.
- 12 Coping with low-quality habitat: white-handed gibbons (*Hylobates lar*) alter diet and activity patterns where fig trees are scarce. L.E. LIGHT.
- 13 Ecological niche modeling of the genus *Papio*. A.J. FUCHS, C.C. GILBERT, J.M. KAMILAR.
- 14 The Effects of Human Surrogacy on Hair Cortisol Levels in Orphaned Baboons (*Papio ursinus*). M.T. WALLER, S. SKINNER, S. FARDI, R.M. BERNSTEIN, H. YOUNG.
- 15 Testing a novel method for collecting salivary cortisol from wild macaques. D.A. BERTRAND, C. BRET, C.M. BERMAN, S.W. MARGULIS, M. HEISTERMANN, A. MUHAMMAD, U. SUTIAH, A. ENGELHARDT.
- 16 Guided by voices: using social media to target small ape surveys in Peninsular Malaysia. T.Q. BARTLETT, S. LAPPAN, N. RUPPERT.
- 17 A Lack of Cathemeral Activity in *Varecia variegata* in Kianjavato, Madagascar. N.K. GUTHRIE, S.M. HOLMES, A.D. GORDON, E.E. LOUIS JR., S.E. JOHNSON.
- 18 Cultural Attitudes Toward Primate Conservation. S. GURSKY.
- 19 Aye-ayes (*Daubentonia madagascariensis*) are not just deadwood specialists: Assessing the importance of live trees to larval foraging. T.M. SEFCZEK, D. RANDIMBIHARINIRINA, B. RAHARIVOLOLONA, D. RABEKIANJA, E.E. LOUIS, JR..
- 20 Tree preference and coexistence of white-faced capuchins and mantled howler monkeys in a Costa Rican forest fragment. R.M. SCHLAHT, A.L. SCHREIER.
- 21 Behavioral and Fecal Hormonal Variation in Vervet Monkeys (*Chlorocebus pygerythrus*) in South African Rehabilitation Centers. A.I. GILLILAND-LLOYD, M.C. SORRENTI, T.R. TURNER.
- 22 A Survey of Crossing Structures among Captive Primates. L.E. GOTUACO, I.J. BROCK, C.M. BRAND, U.S. STREICHER, L.R. ULIBARRI.

### Session 25

#### Human Biology and Genetics I

##### Contributed Poster Presentations

Chair: Noah D. Simons

Acadia

- 1 Diet and health in 18th to 20th century Copenhagen. M.S. JØRKOV, D.R. GRÖCKE.
- 2 Genetics of Psychiatric Disorders and Behavioral Traits Correlate with Geo-climate Variables, Pathogen Diversity, and Language (phonological Complexity in European Populations. R. POLIMANTI, M. KAYSER, J. GELERNTER.

## THURSDAY EVENING SESSIONS

- 3 *Uncoupling Protein 1 (UCP1) and Selection in Warm and Cold Climates.* L. NEVELL.
- 4 *The evolution of the human hippocampus and neuroplasticity.* B.M. SCHILDER, B.J. BRADLEY, C.C. SHERWOOD.
- 5 *The value of understanding intraspecific relationships in comparative analyses.* L. YAO, H. LI, C.S. MOREAU, R.S. MALHI, R.D. MARTIN.
- 6 *The Shape of Selection on Human Life Histories.* J. JONES.
- 7 *Internal craniofacial morphology of high-altitude Tibetans may reflect unique adaptations to hypoxic environments.* L.N. BUTARIC, R. KLOCKE.
- 8 *High heritability and ancestry dominance are behind the genetics of short stature in South African KoeSan populations.* M. LIN, J.M. GRANKA, A.R. MARTIN, J. MYRICK, E.G. ATKINSON, C.J. WERELY, D. GURDASANI, C. POMILLA, T. CARSTENSEN, B. SCELZA, M. MOLLER, M. SANDHU, C.D. BUSTAMANTE, E.G. HOAL, M.W. FELDMAN, C.R. GIGNOUX, B.M. HENN.
- 9 *Identification of Mitochondrial and Y-chromosome Population Structure among Four Aye-aye Populations in Madagascar.* M.L. AYLWARD, S.E. JOHNSON, G.H. PERRY, E.E. LOUIS JR..
- 10 *Megalencephaly and Macrocephaly Genes are Associated with Comparative Variation in Primate Brain Size.* A.R. DECASIEN, A. YIM.
- 11 *Host immune gene expression and viral infection status from whole blood transcriptomes in the Ugandan red colobus.* N.D. SIMONS, G.N. EICK, M.J. RUIZ-LOPEZ, C.A. CHAPMAN, T.L. GOLDBERG, K.N. STERNER, N. TING.
- 12 *A comparative analysis of wild non-human primate gut microbiomes.* R.M. AUSTIN, K. SANKARANARAYANAN, C. WARINNER, C. LEWIS JR.
- 13 *Sex differences in dimorphic dental trait heritability in *Saguinus fuscicollis*.* A.M. HARDIN.
- 14 *Associations between *MHC-DQA1* Regulatory Variation and the Gut Microbiome in the Ugandan Red Colobus (*Procolobus rufomitratu tephrosceles*).* D.M. CHRISTIE, N.D. SIMONS, M. RUIZ-LOPEZ, C.A. CHAPMAN, T.L. GOLDBERG, K. STAGAMAN, B.J. BOHANNAN, N. TING.
- 15 *Rapid, Inexpensive Genotyping and Barcoding of Primates: Multiple Applications for High-resolution Melt Analysis in Primatology and Anthropology.* D.C. FRANKEL, R.L. JACOBS, E.E. LOUIS JR, W.D. HOPKINS, B.J. BRADLEY.
- 16 *FOXP2 Variation in Great Ape Populations offers potential Insights into Variation in Communication.* N. STAES, C.C. SHERWOOD, M.D. MONTERO, J.J. ELY, W.D. HOPKINS, B.J. BRADLEY.
- 17 *Ancient hybridization between *Papio* and *Theropithecus* detected at a non-coding region of the X-chromosome.* A.J. TOSI, C.M. BERGEY, A.S. BURRELL.
- 18 *Genome Partitioning and Telomere Length in Primates and other Mammals.* A.R. KLEGARTH, D.T. EISENBERG.
- 19 *DNA barcodes and the identification of extant and extinct primates.* V. NIJMAN, T. ROBBINS.
- 20 *The New Genus *Paragalago* Suggests Convergent Dwarfism in the family Galagidae.* L. POZZI, J.C. MASTERS.
- 21 *Association of ACE haplotypes and family members in social networks with blood pressure variation in African Americans.* K.C. FULLER, C. MCCARTY, R. VACCA, C.C. GRAVLEE, C.J. MULLIGAN.
- 22 *Adaptive Evolution of *TCIRG1*: A Gene Involved in Bone Development and Remodeling.* A. YIM, S.A. WILLIAMS, T.R. DISOTELL.
- 23 *Optimism and Social Support Buffer Effects of Childhood Disadvantage on Adult Health Behaviors.* E.S. CLAUSING, J.C. ROMÁN, S.E. GILMAN, E.B. LOUCKS, S.L. BUKA, L.D. KUBZANSKY, A.A. APPLETON, A.L. NON.
- 24 *Violence and Prostate Cancer Risk: Chronic Health implications of the Challenge Hypothesis for the Southern American Culture of Honor.* L.C. ALVARADO.
- 25 *Evidence of an ancient origin for contemporary chronic disease risk in South Asia.* E. POMEROY, V. MUSHRIF-TRIPATHY, J.T. STOCK, J.C. WELLS.
- 26 *Effects of Genetics and the Nuclear Family Environment on Shodagor Health.* M.H. AHSAN, K.E. STARKWEATHER.
- 27 *Suicidal Behavior as a Costly Signal of Apology.* K.L. SYME, E.H. HAGEN.
- 28 *Variation in clinical symptoms in sickle cell trait athletes: a study on genetic markers and behavioral traits.* C. FLANSBURG, C.M. BALENTINE, R.W. GRIEGER, J. LUND, M. CIAMBELLA, E. GONZALEZ, D. WHITE, A.C. STONE, L. MADRIGAL.
- 29 *Evidence of Prehistorical Atlantic and Pacific Transoceanic Genetic and Cultural Contacts with America.* A. ARNAIZ-VILLENA, E. MUÑIZ, C. CAMPOS, M. MARTIN VILLA, J. PALACIO-GRUBER.

## THURSDAY EVENING SESSIONS

### Session 26

#### **Paleoanthropology: Late Homo**

##### **Contributed Poster Presentations**

*Chair: P. Thomas Schoenemann*

Acadia

- 1 **Mechanical Properties of the Masticatory System in Recent Northern Chinese populations.** Q. WANG, Q. ZHANG, T. HAN, Z. SUN, M.J. KESTERKE, H. ZHU, P.C. DECHOW, Q. ZHANG.
- 2 **Is Broca's cap really larger on the left in modern humans? Contradictory evidence via Non-rigid diffeomorphic mapping methods.** L.M. KITCHELL.
- 3 **Diploic patterns and vascular morphometrics in fossil specimens.** G. RANGEL DE LAZARO, E. BRUNER.
- 4 **Behavioral traces on dental wear in Pleistocene fossil humans.** A. ESTALRRICH, M. LOZANO, L. BONDIOLI, I. FIORE, J. BERMÚDEZ DE CASTRO, J. ARSUAGA, E. CARBONELL, A. ROSAS, O. KULLMER, D. FRAYER.
- 5 **Using a mouse model to understand the relationship between skeletal and ectodermal trait variation in mammalian hybrids.** R.A. HUMPHREYS, T. RITZMAN, K. WARREN, C.J. PERCIVAL, B. HALLGRIMSSON, R.R. ACKERMANN.
- 6 **Human remains and artefacts from Romualdo's cave, Istria, Croatia.** I. JANKOVIĆ, J.C. AHERN, D. KOMŠO, S. MIHELIĆ, F.H. SMITH.
- 7 **Dolichocephaly and occipital hemi-bun development in extant humans.** M.E. KARBAN.
- 8 **The database of Worldwide Instances of Symbolic Data Outlining Modernity.** M. KISSEL, A. FUENTES.
- 9 **It's all in the wrist: New Neandertal carpal bones from El Sidrón (Asturias, Spain).** T.L. KIVELL, A. ESTALRRICH, R. HUGUET, A. GARCIA-TABERNERO, L. RIOS, M. DE LA RASILLA, A. ROSAS.
- 10 **The origin of our species: an ancestral morphotype for modern humans.** A. MOUNIER, M. MIRAZÓN LAHR.
- 11 **Modern Human Variation in Brain Size: Implications for the Dmanisi Hominins and other Fossil Taxa.** P. SCHOENEMANN, R.L. HOLLOWAY.
- 12 **Trabecular Bone Properties in the Border Cave 3 Infant Ilium: Implications for the onset of Independent Gait in Early Modern *Homo sapiens*.** K.A. TOMMY, B. ZIPFEL, J. KIBII, K.J. CARLSON.
- 13 **Neanderthal Dental Remains from Chagyrskaya cave, Altai Mountains, Siberia.** B. VIOLA, S.V. MARKIN, N. RUDAYA, S. VASILYEV, K. KOLOBOVA.
- 14 **Craniofacial Variation in Middle Pleistocene Hominins.** S. WHITE, S. HILLSON, C. SOLIGO.
- 15 **Comparison of Neandertal Mandibular First Molar Occlusal Outlines using Elliptical Fourier Function Analysis.** F. L'ENGLE WILLIAMS, J.K. BROPHY.
- 16 **Virtual cranial restoration of Qafzeh 6 by new methodology using photogrammetry.** D. COUTINHO NOGUEIRA, B. DUTAILLY, F. COMTE, A. TILLIER, H. COQUEUGNIOT.
- 17 **Paleoenvironmental Reconstruction of the Koanaka Hills Pleistocene Fossil Locality in Botswana.** Z.W. PIERCE, T.L. CAMPBELL, P.J. LEWIS.
- 18 **Coordinate-system-invariant Assessment of Measurement Error in Landmark Coordinate Data.** T.M. COLE III, L. HU, S.R. LELE, J.T. RICHTSMEIER.
- 19 **The impact of shared evolutionary history on the observed morphological differences in the femoral mid-shaft between archaic and modern humans.** B.L. MOODY.
- 20 **Examination of Neandertal maxillary first molar occlusal outlines using Elliptical Fourier Analysis.** W.G. ANDERSON, F. WILLIAMS.
- 21 **Neandertal Dental Microwear Texture Analysis from l'Hortus: A Bioarchaeological Perspective.** J.L. DROKE, F. L'ENGLE WILLIAMS, C.W. SCHMIDT, J.C. WILLMAN.
- 22 **Finite Element Modeling of Talar Loading in Modern Humans with Application to the Hominin Fossil Record.** Z.S. SWANSON, N.M. WEBB, H. PONTZER, J.M. DESILVA, W.E. HARCOURT-SMITH.

### Session 27

#### **Bioarchaeology and Paleopathology: Stress, Frailty, and Inequality**

##### **Contributed Poster Presentations**

*Chair: Larissa Collier*

Acadia

- 1 **Connected Lives: Maternal Health in Medieval and Post-medieval England.** A.C. JONES, T. JAKOB.
- 2 **The Impact of Multiple Skeletal Stress Markers on Survivorship and Longevity.** J.D. MINSKY-ROWLAND.
- 3 **Subadult Stress: continental Croatia vs Adriatic coast.** M. KLJAJIC LUKACEVIC, M. WOJCINSKI, M. SLAUS.
- 4 **A characterization of nutritional stress among early Medieval subadult females of the central Dalmatian region of Croatia.** L.J. THORSON, V. VYROUBAL, M. ŠLAUS.

## THURSDAY EVENING SESSIONS

- 5 **Stressful times: Investigating childhood health in urban and rural medieval Britain.** E.R. DOVE, J.D. IRISH, C. ELIOPOULOS, I. DE GROOTE.
- 6 **Stress in Transylvania: Utilizing macroscopic skeletal analysis to track metabolic and nutritional stress between Late Antiquity and Middle Ages in Romania.** K.D. CROWDER, C.A. ROBERTS.
- 7 **Assessing skeletal indicators of childhood stress amongst 20th century northeastern (Isan) Thais.** M. PANAKHYO, N. TECHATAWEEWAN.
- 8 **Childhood and Famine in Medieval London.** S.L. YAUSSY, S.N. DEWITTE.
- 9 **Analysis of Growth Disruptions in two Burial Populations in the Greek Colony of Himera.** A.H. ZAHID, B. KYLE, N. LONOCE, A. SMITH, S. VASSALLO, P. FABBRI, L.J. REITSEMA.
- 10 **An Inside View: Childhood Stress at the Greek Colony, Himera.** M. CHOWNING, C. GARLAND, B. KYLE, S. VASSALLO, L.J. REITSEMA.
- 11 **Examining the osteological paradox: frailty in mass graves versus the general population at the Greek colony of Himera.** J. TYLER, B. KYLE, A. SMITH, S. VASSALLO, P. FABBRI, L.J. REITSEMA.
- 12 **The Cost of Early Stress in the Later Stone Age: Temporal Variation in the Relationship between Neural Canal Size and Early Mortality Among Adult Foragers.** L. DOYLE.
- 13 **Childhood Death in a Southwest Basketmaker II Community.** D.M. MULHERN, M.C. CHARLES.
- 14 **Methodological Comparison of the Macroscopic vs. Radiographic Assessment of Cranial Porosities within the Texas State University Donated Skeletal Collection.** B.S. MCCLAIN, M.D. HAMILTON.
- 15 **Childhood stress among the Postclassic Maya of Mayapan.** S. SERAFIN.
- 16 **Stressed Before Sacrifice? Reconstructing Psychosocial Stress from Archaeological Hair at Chotuna-Chornancap, Peru.** B.J. SCHAEFER, B.L. TURNER, H.D. KLAUS.
- 17 **Skeletal Stress Markers in Undocumented Border Crossers: A Comparative Approach.** A. GOOTS, L.A. MECKEL, D.S. GLEIBER, A. AYALA BAS.
- 18 **Porotic hyperostosis versus cribra orbitalia for prehistoric populations from the southeastern United States: contributions to the etiology debate.** T. SOMOGYI, E.A. DIGANGI.
- 19 **Paleopathological Assessment of Health and Social Status in a Texas Gulf Coastal Plains Population.** J.A. PYLE, C.C. SIEGERT, M.D. HAMILTON.
- 20 **Health Conditions of Enslaved Africans, Freeman and Poor White Workers: A Biocultural Approach.** A. LESSA, G.N. CAMPOS, R.B. TAVARES.
- 21 **Effects of Social Transition on Health at Tumilaca la Chimba, Peru.** S.A. LOWMAN, B. TURNER, N. SHARRATT.
- 22 **Health, inequality, and conquest in Warring States China.** E.S. BERGER, L. CHEN, J. SHAO, Z. SUN.
- 23 **Framing Function, Health, and Disability in the Roman Iron Age: Application of the ICF in Two Individuals with Developmental Dysplasia of the Hip.** L. COLLIER, L. LOWE.
- 24 **Hip fractures and survivorship in old age: investigating trauma in the archaeological record.** M.L. MANT, R. IVES, C. DE LA COVA, M. BRICKLEY.
- 25 **Finding Etruscan Bones: Confocal Laser Scanning Microscope in archaeological context.** L. GASPARI, M. SANNIBALE, F. DE ANGELIS, P. CATALANO, O. RICKARDS.
- 26 **Feeding the City: dietary variation in several communities of Roman *Suburbium* (I-III centuries CE).** F. DE ANGELIS, S. VARANO, G. AMICUCCI, A. BATTISTINI, C. CALDARINI, S. DI GIANNANTONIO, R. MOSTICONE, W. PANTANO, F. ZAVARONI, C. MARTÍNEZ-LABARGA, P. CATALANO, O. RICKARDS.
- 27 **Sex-specific patterns in age-related cortical and trabecular bone loss: A 2-D histomorphometric study using mid-thoracic ribs.** A.C. BERESHEIM.

### Session 28

#### **Human Dental Anthropology: Health, Disease, and Other Cool Stuff with Teeth**

##### **Contributed Poster Presentations**

*Chair: Christina L. Fojas*

Acadia

- 1 **The dawn of dentistry in the Late Upper Paleolithic.** G.M. OXILIA, F.M. FIORILLO, F.D. BOSCHIN, E.D. BOARETTO, S.M. APICELLA, C.D. MATTEUCCI, D.D. PANETTA, R.P. PISTOCCHI, F.P. GUERRINI, C.M. MARGHERITA, M.D. ANDRETTA, R.M. SORRENTINO, G.P. BOSCHIAN, S.M. ARRIGHI, I.D. DORI, G.M. MANCUSO, J.D. CREZZINI, A.D. RIGA, M.M. SERRANGELI, A.M. VAZZANA, P.P. SALVADORI, M.P. VANDINI, C.P. TOZZI, A.P. MORONI, R.D. FEENEY, J.D. WILLMAN, J.P. MOGGI-CECCHI, S.D. BENAZZI.
- 2 **Intentional Dental Staining in the Mariana Islands.** R.M. IKEHARA-QUEBRAL, T.M. RIETH, A.E. MORRISON, M. PIETRUSEWSKY, M. DOUGLAS.

## THURSDAY EVENING SESSIONS

- 3 Odontometric Sex Assessment at the Early Bronze Age site of Ostojićevo (Serbia). A.N. KARABOWICZ, K.M. POMPEANI.
- 4 Differences in the non-masticatory dental wear of two medieval assemblages from the 4th cataract, Sudan. R.J. WHITING, S. HILLSON, D. ANTOINE.
- 5 Regional Variation of Dental Microwear in the English Late Bronze Age and Iron Age. R.L. PERASH.
- 6 Differentiating Dental Wear Patterns: A Dental Microwear Study on the Philistine Population from Ashkelon. R.E. KALISHER.
- 7 Something To Chew On: Comparing Dentin Exposure in Ancient Egyptians and Dental Age Estimation Standards. C.L. KIRKPATRICK.
- 8 The applicability of dental wear in age estimation for a modern American population. K.E. FAILLACE, J.D. BETHARD, M.K. MARKS.
- 9 A new method for estimating age from deciduous teeth in archaeological contexts. J. BECK.
- 10 Initiation of Permanent Premolar Tooth Crypt Formation in Individuals with Premolar Agenesis. M. ŠEŠELJ.
- 11 A Study of Human Tooth Eruption and Root Growth. H.M. LIVERSIDGE.
- 12 Estimating Age at Death through Cementum Annulations in Canines and 1st Molars: A Late Formative Period (400 B.C. - 150 B.C.) Population from Cerro de la Cruz in the Lower Río Verde Valley of Oaxaca, Mexico. C. VEGA, A.T. MAYES, A.A. JOYCE.
- 13 Biorhythm tracks enamel thickness in humans and great apes. P. MAHONEY, J.J. MISZKIEWICZ, R. PITFIELD, C. DETER, D. GUATELLI-STEINBERG.
- 14 Human incremental hard tissue formation as evidence of a biorhythm: preliminary results. R. PITFIELD, P. MAHONEY.
- 15 Prenatal crown formation time of human deciduous central incisors in a pre-industrial population. A. NAVA, P.F. ROSSI, L. BONDIOLI.
- 16 Trace Element Studies Support Rapid Tooth Enamel Mineralization at the Enamel-Dentine Junction. T.M. SMITH, C. AUSTIN, D. GREEN, M. ARORA.
- 17 Growing up in Çatalhöyük : enamel hypoplasia and history houses. E. BOCAEGE, A. CLEMENT, S. HILLSON.
- 18 A lesson in stressin': A comparison of linear enamel hypoplasias in children from the prehistoric Ohio Valley. E. MOES, S. BLATT.
- 19 Linear enamel hypoplasia incidence in bush-dwelling and village Hadza from Tanzania. P.S. UNGAR, A.N. CRITTENDEN, J.C. ROSE.
- 20 Climate Change and Enamel Defects: Interpreting the Childhood Stress of Early Levantine Agriculturalists. T.V. WILSON.
- 21 Tooth size, trait expression, and nutritional stress. E.C. BLANKENSHIP-SEFCZEK, D. GUATELLI-STEINBERG, A.H. GOODMAN.
- 22 Sex-Related Differences in Dental Caries Prevalence in the Prehistoric American Southwest. R.T. WINEINGER.
- 23 Dental Health and Diet at Tell el-Amarna: A Comparison of Carious Lesions, Dental Wear, and Antemortem Tooth Loss in Dynastic Egypt. E.L. MOREY.
- 24 Dietary Reconstruction of Winnebago Phase Oneota: A Study of Dental Pathology. J. KARSTEN, T. DORSHORST, K. KUBEHL, L. SCHEIDER.
- 25 Oral health among the Hadza foragers of Tanzania. A.N. CRITTENDEN, S. MOONIE, J. SORRENTINO, P.S. UNGAR.
- 26 Heterogeneity in Oral Health in Middle Tennessee during the Mississippian Period. C.L. FOJAS.
- 27 A large-scale analysis of the prevalence of dental caries and calculus over time, from the Bronze Age to the Post-medieval period in Britain. C.S. HIRST.
- 28 Disease and dental wear on the upper Texas coast: Cross-era comparison of Native American Health at site 41GV66. E.A. EDWARDS.
- 29 A new perspective on the population history of the pre-Incan South Central Andes through analysis of dental morphological data. A. CUCINA, A. COPPA, C. ARGANINI, F. CANDILIO.
- 30 Dental Modification and Human Sacrifice at Midnight Terror Cave. C. VERDUGO, K. ZHU, L. FEHREN-SCHMITZ.
- 31 Refining a Traditional Method in Dental Wear Analysis for Greater Application. E.M. LAGAN.
- 32 An assessment of oral health in prehistoric Ancón, Peru. C. MONESMITH.
- 33 Ethnic diversity in a 19th Century Colorado Insane Asylum: what the teeth tell us. E. HUBBARD, F. ERBIL, M. GLANTZ, A. MAGENNIS.
- 34 Hutchinson's dental criteria diagnose congenital syphilis in pre-Columbian Old World. S. IOANNOU, R.J. HENNEBERG, M. HENNEBERG.

# FRIDAY, MORNING SESSIONS

## Session 29

### Human Skeletal Biology: Shape, Selection, Integration, and Kinship

#### Contributed Podium Presentations

Chair: Maureen J. Devlin

Balcony I/J

- 8:00 Differences in Adult Female Human True Pelvis Morphology with Respect to Age are Not Due to Selection. B.M. AUERBACH.
- 8:15 Combining functional and forward genomics to explore the evolutionary developmental regulation of primate long bone length variation. T.D. CAPELLINI, M. HILLER, J. WILLEN, A.W. WOHNS, H. DINGWALL.
- 8:30 High Fat, High Protein Diet Increases Bone Density in Cold-exposed Mice: Implications for Humans. M.J. DEVLIN, A.E. ROBBINS, M.N. COSMAN, L.M. SHIPP, T.R. BRASH.
- 8:45 Worldwide modern human morphological variation: exploring the association between morphological modules and climate and geographic distances. K.I. DOWNEY, B. HERRERA, M. HUBBE.
- 9:00 Geography More than the Chronological Depth Explains the Structure of the Human Cranial Diversity. D.V. BERNARDO, T.F. DE ALMEIDA, T.C. CAMPOS, W.A. NEVES.
- 9:15 Integration Between the Lower Face and the Dentition throughout Ontogeny. A. NESBITT.
- 9:30 Integration between the cranium and mandible in recent humans. D.C. KATZ, M.N. GROTE, T.D. WEAVER.
- 9:45 Cranial integration is a major determinant of endocranial and brain shape. C.P. ZOLLIKOFER, T. BIENVENU, M.S. PONCE DE LEÓN.
- 10:00 Break.
- 10:30 Midline Bony Landmarks are Poor, but better than Soft Tissue Landmarks, for Estimating Population Affiliation in Unknown Individuals. H.J. EDGAR, K. GWIN, K. RUSK.
- 10:45 Evaluating the Limitations of Biological Distance Models of Gene Flow in Ancient Human Populations. A.M. MALLARD, J.T. WATSON, B.M. AUERBACH.
- 11:00 Social network analysis of cranial shape among Moquegua Tiwanaku-affiliated communities: a regional approach to kinship analysis. K.M. JOHNSON.
- 11:15 Can diaphyseal (cross-sectional) properties of arm and leg bones detect among-population genetic relationships? G. AGOSTINI, B. HOLT.
- 11:30 Comparative performance of deciduous and permanent dental morphology in reconstructing biological kinship. K.S. PAUL, C.M. STOJANOWSKI.
- 11:45 Population continuity and replacement in the pre-contact Valley of Mexico. C.S. RAGSDALE, H.J. EDGAR.
- 12:00 Defining the "Outsiders": a biodistance analysis of Ottoman communities in Hungary and Romania. K. GROW ALLEN, N. VON CRAMON-TAUBADEL.

## Session 30

### Paleoanthropology: Early Homo

#### Contributed Podium Presentations

Chair: Shelby S. Putt

Bissonet

- 8:00 Bovid locomotor traits track land cover and mean annual precipitation: using an ecometric approach to reconstruct paleoenvironments in the Shungura Formation (Plio-Pleistocene, Ethiopia). W. BARR.
- 8:15 Exploring the Utility of Carbon Isotope Analyses of Small Mammal Tooth Enamel as an Environmental Proxy. J.N. LEICHLITER, P. SANDBERG, M.J. SPONHEIMER, B. PASSEY, N. AVENANT, O. PAINE, D. CODRON, J. CODRON.
- 8:30 Hybridization and reticulation in hominin evolution. J.R. GAUTNEY, T.W. HOLLIDAY.
- 8:45 New insights into locomotion and posture in hominoid evolution: integration of the skull and cervical vertebrae. C.I. VILLAMIL.
- 9:00 Relative fibular strength and locomotor behavior in OH 35 and KNM-WT 15000. C.M. HARPER, D. MARCHI, H. CHIRCHIR, C.B. RUFF.
- 9:15 Virtual reconstruction of the pelvic remains of KNM-WT 15000 *Homo erectus* from Nariokotome, Kenya. C. FORNAI, M. HAEUSLER.
- 9:30 *Homo naledi's* frontal lobe: Modern in form, ancestral in size. S.D. HURST, R.L. HOLLOWAY, H.M. GARVIN, T. SCHOENEMANN, W.B. VANTI, J. HAWKS, L.R. BERGER.
- 9:45 *Homo naledi* posterior endocasts and their significance for understanding brain reorganization. R.L. HOLLOWAY, S. HURST, H.M. GARVIN, T. SCHOENEMANN, W.B. VANTI, J. HAWKS, L. BERGER.
- 10:00 Break.

## FRIDAY MORNING SESSIONS

- 10:30 Functional Neuroimaging Insights into Acheulian Cognition and Hominin Brain Evolution. S.S. PUTT, S. WIJEAKUMAR, R.G. FRANCISCUS, J.P. SPENCER.
- 10:45 A morphometric assessment of *Homo naledi* deciduous molar teeth from Dinaledi Chamber, Rising Star cave system, South Africa. J.K. BROPHY, S.E. BAILEY, J. MOGGI-CECCHI, L.K. DELEZENE, M. SKINNER, D.J. DE RUITER.
- 11:00 Metric Variation in *Homo naledi* Molars. L.K. DELEZENE, J.D. IRISH, M.W. SKINNER, J. BROPHY, J. HAWKS, L.R. BERGER.
- 11:15 The limb proportions of *Homo naledi*. S. TRAYNOR, J. HAWKS.
- 11:30 Functional and Evolutionary Implications of the *Homo naledi* Rearfoot. T.C. PRANG.
- 11:45 Hamadryas baboons as analogs for social evolution in early Homo. L. SWEDELL, T. PLUMMER.
- 12:00 A deformation-based approach to the frontal lobe morphology in OH9, UA 31 and Bodo. A. BEAUDET, E. BRUNER.
- 9:15 BRAAAAINS!!! Chimpanzees at Gombe consume monkeys head-first. I.C. GILBY, D. WAWRZYNIAK.
- 9:30 Feverish Monkeys get Kicked when they're Down. R. MCFARLAND, L. BARRETT, A. FULLER, P. HENZI, S.K. MALONEY, D. MITCHELL, C. YOUNG, R.S. HETEM.
- 9:45 Individual differences in spatial position during collective movements of vervet monkeys. M.B. BLASZCZYK.
- 10:00 Break.
- 10:30 Identifying the Ecological Mechanisms Promoting Long-term Co-existence in a Mega-diverse Assemblage of Vertebrate Frugivores at Gunung Palung National Park, West Kalimantan, Indonesia. A.J. MARSHALL, L. BEAUDROT, H.U. WITTMER.
- 10:45 Ranging patterns and behaviour of Javan slow lorises in a dynamic agroforestry landscape in West Java. A.I. NEKARIS, S.A. POINDEXTER, K.D. REINHARDT, M.A. SIGAUD, V.J. NIJMAN.
- 11:00 Fifteen Years of Forest Fragmentation in Southeastern Madagascar: Making sense of Fragmented Results. K.J. KLING, Z. ANDRIANDRASANA, A. DEHGAN, P.C. WRIGHT.
- 11:15 Quantifying *Microcebus* Habitat Loss Due to Roads. M.S. RAMSAY, A. RAZAFINDRAKOTO, H.N. RAVELONJANAHARY, S.M. LEHMAN.
- 11:30 Abrupt decline in mantled howlers (*Alouatta palliata*) but not in sympatric white-faced capuchins (*Cebus capucinus imitator*) in a tropical dry forest conservation area in Costa Rica. F.A. CAMPOS, K.M. JACK, L.M. FEDIGAN.
- 11:45 Variation in prey choice and hunting efficiency by season and technology among indigenous Waiwai hunters in Guyana. C.A. SHAFFER, C. YUKUMA, E. MARAWANARU, P. SUSE, M.S. MILSTEIN.
- 12:00 Strontium Isotope Ratios Indicate Mobility, Behavior Patterns in Modern Fauna from Kibale National Park, Uganda. M.I. HAMILTON.

### Session 31

#### Primate Ecology, Cognition, and Conservation

##### Contributed Podium Presentations

Chair: Fernando A. Campos

Studio 1/2/3

- 8:00 Pairing Feeding Observations with Stable Isotope Data from Bonobo (*Pan paniscus*) Fecal Samples from the Lomako Nature Reserve, Democratic Republic of the Congo. J.E. LOUDON, H.M. KIMEL, M.T. WALLER, M.L. WAKEFIELD, A. HICKMOTT, F.J. WHITE, M. SPONHEIMER.
- 8:15 Patch-use Decisions in Geladas: Effects of Body Size and Food Type. L. CHRISTOPHER, V.V. VENKATARAMAN, J.T. KERBY, N. NGUYEN, P.J. FASHING.
- 8:30 I Did it My Way!: Three Nocturnal Lemur Species show Intraspecific Inter-individual Variation when Solving a Multi-destination Route. J.A. TEICHROEB, A.Q. VINING.
- 8:45 Comparative foraging strategies of Neotropical frugivores: Do primates forage 'smarter'? M.C. CROFOOT, R. MAREST, D. CAILLAUD, R. KAYS, B. HIRSCH.
- 9:00 The ontogeny of manipulation complexity within 26 primate species. S.A. HELDSTAB, J.M. BURKART, C.P. VAN SCHAIK, K. ISLER.
- 8:00 Innate food aversions and culturally transmitted food avoidances in pregnancy: separate systems to protect the fetus? E.H. HAGEN, C.D. PLACEK.

### Session 32

#### Human Biology: Evolutionary Perspectives on Reproduction, Development, and Health

##### Contributed Podium Presentations

Chair: Aaron D. Blackwell

Studio 7/8/9

## FRIDAY MORNING SESSIONS

- 8:15 The “cliff edge model” of human obstetric selection. P. MITTEROECKER.
- 8:30 Excessive gestational weight gain and birth outcomes among American Indians and Alaska Natives. K.G. ANDERSON, P. SPICER, M.T. PEERCY, G. SKREPNEK.
- 8:45 Paternal grandmothers increase and maternal grandmothers decrease fertility of couples they reside with. G. JASIENSKA, M. JASIENSKI, A. GALBARCZYK, I. NENKO, M. KLIMEK.
- 9:00 Maternal and paternal anthropometry influences on body size, body shape and obstetric capacity in growing girls. S. DECRAUSAZ, J.T. STOCK, M.S. FEWTRELL, J.E. WILLIAMS, J.C. WELLS.
- 9:15 The human voice conveys information on developmental stability. A.K. HILL, R.A. CÁRDENAS, J.R. WHEATLEY, L.L. WELLING, R.P. BURRIS, P. CLAES, C.L. APICELLA, M.A. MCDANIEL, A.C. LITTLE, M.D. SHRIVER, D.A. PUTS.
- 9:30 Opportunity costs from potential nighttime activities trade off against time allocated to sleep behavior among Tsimane hunter-horticulturalists. G. YETISH, H. KAPLAN, M. GURVEN.
- 9:45 Divisions of Labor at Daily Timescales among Batek Hunter-Gatherers. V.V. VENKATARAMAN, T.S. KRAFT, K.M. ENDICOTT.
- 10:00 Break.
- 10:30 Life History Transitions: Parents Still Matter more than Female Friends for Adolescent Girls’ Mental Health. M.A. RODRIGUES, S.R. SANFORD, M.P. ROGERS, K.M. LEE, S.J. GAY, R.A. MITCHELL, Z. SULTANA, J. AMOS, C.D. HUNTER, K.B. CLANCY.
- 10:45 Atherosclerosis in contemporary preindustrial populations: does it exist and is it clinically relevant? M.D. GURVEN, B.C. TRUMBLE, J. STIEGLITZ, B. BEHEIM, A.D. BLACKWELL, D. MICHALIK, A.H. ALLAM, C. ROWAN, B. FROHLICH, L. SUTHERLAND, J.D. SUTHERLAND, J.K. MIN, C.E. FINCH, S. WANN, R.C. THOMPSON, G.S. THOMAS, H.S. KAPLAN.
- 11:00 Human parasitism in a comparative context: Are humans exceptionally parasitized? C.R. AMOROSO, C.L. NUNN.
- 11:15 Unwelcome Guests: Human-rodent Commensalism and its Implications for Zoonotic Disease Transfer. C.M. MCCABE, H.S. YOUNG, S.B. WEINSTEIN, C.L. NUNN.
- 11:30 Immune function across the life-span in Amazonian horticulturalists. A.D. BLACKWELL, B.C. TRUMBLE, I. MALDONADO SUAREZ, J. STIEGLITZ, B. BEHEIM, J. SNODGRASS, H. KAPLAN, M. GURVEN.

- 11:45 The Importance of Ethnographic Data and Social Network Structures in Determining Infection Risk for Individuals in Rural Communities of Bangladesh and Uganda. L.S. BLOOMFIELD, A. HAZEL, J.H. JONES.
- 12:00 Remoteness Influences Access to Sexual Partners and Drives Patterns of Viral Sexually Transmitted Disease Prevalence among Nomadic Pastoralists. A. HAZEL, J. HOLLAND JONES.

### Session 33

#### Here Comes the Sun: Evolutionary Responses to Solar Exposure

##### Invited Poster Symposium

*Organizers/Chairs: Ellen E. Quillen, Nina G. Jablonski*

##### Balcony K

Throughout human evolution and recurrently in diverse environments, pigmentation genes have undergone some of the strongest intervals of selection found in the genome. Selection and genetic drift have shaped local genetic variation in striking ways. This symposium focuses on recent work on the genetics of skin pigmentation with a particular focus on distinct manifestations of overlapping allelic variation among populations. Comparison with our non-human primate relatives provide deeper perspectives on the evolutionary history of pigmentation variation while studies of more recent gene flow and admixture have generated novel interactions between genes influencing constitutive skin color within populations. Variation in constitutive pigmentation informs, but is insufficient to explain, variation in response to ultraviolet radiation. Increasingly, the genetic architectures of facultative pigmentation (tanning), vitamin D production, and epidermal thickening in response to solar exposure are being elucidated with both classic pigmentation genes and novel alleles influencing these biomedically and forensically important traits. By considering both constitutive pigmentation and these labile traits, which are heavily influenced by both genetics and the environment, we seek a more complete picture of variation in human skin.

- 8:00 Introduction: Ellen E. Quillen.
- 8:05 Individual poster presentations (Posters #1-7).
- 10:30 Individual poster presentations (Posters #8-12).
- 11:15 Discussant: Nina G. Jablonski.
- 1 Pigmentation variation in the presence of strong UVR: genetic and phenotypic variation in Island Melanesia. H.L. NORTON, L. BOWSER, J.S. FRIEDLAENDER.

## FRIDAY MORNING SESSIONS

- 2 **Genetics of pigmentation in East Asia: The role of *OCA2* polymorphisms.** L. RAWOFI, M. EDWARDS, S. KRITHIKA, N. MURRAY, H.L. NORTON, E.J. PARRA.
- 3 **Rapid Evolution of Lighter Skin Pigmentation in Southern Africa.** B.M. HENN, M. LIN, A.R. MARTIN, R. SIFORD.
- 4 **The complicated genetic landscape of skin color in India.** F. ILIESCU, G. CHAPLIN, N. RAI, G. JACOBS, C. BASU MALLICK, A. MISHRA, R. GOTO, R. TAMANG, G. CHAUBEY, I. GALLEGOM ROMERO, F. CRIVELLARO, R. PITCHAPPAN, L. SINGH, M. MIRAZON-LAHR, M. METSPALU, K. THANGARAJ, T. KIVISILD, N.G. JABLONSKI.
- 5 **Variation in skin reflectance and pigmentation genes in young adults of Xhosa and Cape Mixed ancestry from the Western Cape, South Africa.** N.G. JABLONSKI, T. LASISI, A. ABHIMANYU, A.K. COUSSENS, C.E. NAUDE, G. CHAPLIN, L.N. PEARSON, R. GOLIATH, M.D. SHRIVER, R.J. WILKINSON.
- 6 **Fluidity of "Color" among Brazilians Investigated using Genomic Ancestry, Skin Pigmentation, and Facial Ancestry.** L.N. PEARSON, D.A. HERNANDEZ, P. CLAES, R.W. PEREIRA, M.D. SHRIVER.
- 7 **Mapping the Origins of Inter-Population Skin Color Variation with Admixed Indigenous Populations.** K.C. ANG, V.A. CANFIELD, T.C. FOSTER, M.S. NGU, J. HAWLEY, M.M. CLYDE, B.M. MD-ZAIN, G. MEISENBERG, S.J. OPPENHEIMER, K.C. CHENG.
- 8 **Pigmentation in a Comparative Context: Factors Shaping Variation and Convergence in Primate Pelage Patterns.** B.J. BRADLEY, J.M. KAMILAR, A.N. SPRIGGS, B.C. WILHELM, S. WALSH.
- 9 **The prediction of human pigmentation phenotypes from DNA for forensic and anthropological usage.** S. WALSH, K. BRESLIN, R. ELLER, C. MURALIDHARAN, E. POSPIECH, L. CHAITANYA, A. WOLLSTEIN, F. LIU, W. BRANICKI, M. KAYSER.
- 10 **A Complex, Polygenic Architecture for Lightened Skin Pigmentation in the Southern African KhoeSan.** A.R. MARTIN, C.R. GIGNOUX, M. LIN, J.M. GRANKA, A. ADAMS, X. LIU, E.G. ATKINSON, C.A. GUENTHER, S. BELEZA, C.J. WERELY, J. MYRICK, M. MÖLLER, D.M. KINGSLEY, M.J. DALY, M.W. FELDMAN, E.G. HOAL, C.D. BUSTAMANTE, B.M. HENN.
- 11 **The role of *FZD6* in the evolution of tanning response in the Americas.** E.E. QUILLEN, J. FOSTER, A. SHELDRAKE, N.G. JABLONSKI, M.D. SHRIVER.
- 12 **Complex adaptive forces shape skin barrier evolution in humans.** Y. LIN, M. EAASWARKHANTH, P. PAJIC, D. XU, M. RZHETSKAYA, M. HAYES, R. BLEKHMANN, N. JABLONSKI, O. GOKCUMEN.

### Session 34

#### **Adaptation: Identifying Form-Function Relationships in the Fossil Record**

##### **Invited Poster Symposium**

*Organizers/Chairs: Marisa E. Macias, Kari L. Allen*

**Studio 4/5**

A primary goal of paleoanthropology is to understand the relationship between form and function in extinct taxa. Interpretation of the form/function relationship requires an unambiguous definition of adaptation and a formalized set of criteria for the identification of this in the fossil record. Best practices involve a combination of indirect - comparative method using extant taxa - and direct - observation of the fossil record - approaches. In the the last few decades, we have seen an explosion of new methodology for evaluating associations between morphology and function using phylogenetic, morphometric, and evolutionary modeling approaches. Researchers have necessarily specialized in these approaches, creating discrete subfields within paleoanthropology. The aim of this symposium is to facilitate the synthesis of disparate methods and theoretical approaches for a more nuanced and holistic understanding of functional adaptations in primate evolution. This session will bring together researchers with a deep interest and expertise in 1) the construction of theoretical framework from which to assess the presence of adaptation in fossil taxa, 2) novel techniques in testing for adaptive evolution, and 3) the application of adaptive theoretical framework to a specific anatomical system, ecological variable, or primate clades. This session highlights a broad range of focuses, covering functional systems throughout the body, as well as across evolutionary time to discuss best practices for incorporating explicit theoretical framework into the understanding of the form-function relationship within the primate fossil record.

**10:30 Discussant: Richard F. Kay.**

- 1 **Combining Indirect and Direct Evidence for the Coevolution of Brain Size and Diet in Primates.** K.L. ALLEN.
- 2 **Platyrrhine dynamic dental topography: implications for secondary dental morphology in brachyodont, long-lived taxa.** J.D. PAMPUSH, J.P. SPRADLEY, J.T. GLADMAN, D. GRIFFITH, L.A. GONZALES, R.F. KAY.
- 3 **New specimens of *Stirtonia* from the La Victoria Formation, La Venta, Colombia and the evolution of alouattin dental and mandibular form.** S.B. COOKE, A. VANEGAS, A. LINK, B.M. SHEARER, L.K. STROIK, M. TALLMAN.

## FRIDAY MORNING SESSIONS

- 4 **Adaptive plasticity in the masticatory apparatus: inferences for form, function, and fossils.** C.E. TERHUNE, A.D. SYLVESTER, S. COINER-COLLIER, J.E. SCOTT, K.R. MCABEE, M.J. RAVOSA.
- 5 **You are how you eat: elucidating chewing patterns through 3D shape analysis of fossil primates.** K.P. MCNULTY, R.P. KNIGGE, C.J. VINYARD.
- 6 **Testing hypotheses about early hominin feeding adaptations.** D.S. STRAIT.
- 7 **The role of experimental approaches to the interpretation of form-function relationships in the fossil record.** S.G. LARSON.
- 8 **Inferring hominoid locomotor adaptation from bones: insights from the torso skeleton.** C.V. WARD, E.R. MIDDLETON.
- 9 **Adaptations in the upper limb of *Australopithecus*.** M.E. MACIAS, M. GRABOWSKI.
- 10 **Anatomical Determinants of Dysfunction Inform the Evolution of the Human Shoulder.** N.M. YOUNG, N.T. ROACH, S. HERFAT, M. RAINBOW, M. MARMOR, B. FEELEY, T. BAUM, M. BEY.
- 11 **Primate femoral condyle curvature: linking shape and locomotion.** A.D. SYLVESTER.
- 12 **Testing hypotheses about hominin locomotor evolution using models not analogies.** D.E. LIEBERMAN, M.M. BARAK, C.P. ROLIAN, D.A. RAICHLLEN, H. PONTZER.
- 13 **Primate Communities: Behavior and Morphology.** J.G. FLEAGLE, K.E. REED, N. NAQVI, J. SMAERS.

### Session 35

#### **Anthropological Stories of Bone Histology and Remodeling: An Invited Session in Honor of Samuel D. Stout**

##### **Invited Poster Symposium**

*Chair: Sabrina C. Agarwal*

Studio 6

Sam Stout pioneered the early work on bone histomorphometry in ancient bone, and over the past decades his work has established the significant methodological and scientific contribution of histological studies to biological anthropology. He has examined some of the most fundamental aspects of skeletal variation including patterns in bone remodeling with disuse, taphonomy, population variation, biomechanical loading, bone remodeling in early hominids, and changes with disease and aging. He has continued to develop new microscopic age estimation methods and push our understanding of intra-skeletal variation in bone mass and microstructure. This session brings together the research of his colleagues and the students he has mentored

to celebrate the stories and new trajectories from this work that have served to clarify the fundamentals of bone biology for generations of scholars in skeletal biology, forensic anthropology, paleoanthropology and bioarchaeology.

8:00 **Introduction: Sabrina C. Agarwal.**

10:30 **Participant Discussion.**

- 1 **An analysis of infant bone composition using Raman Spectroscopy.** M.E. SOTO MARTINEZ, C.M. CROWDER, X. BI.
- 2 **After 25 years, revisiting clavicle histology.** R.R. PAINE.
- 3 **Applications of bone histomorphometry in bioarchaeology, forensic anthropology, and clinical studies.** H. CHO.
- 4 **Observer Variability in Identification of Histological Structures in Silver-Stained Bone Thin Sections.** D.C. PINTO, C.M. CROWDER, G.T. PHILLIPS.
- 5 **Histological indicators of stress.** E. RAGUIN, M.A. STREETER, M.S. DRAPEAU.
- 6 **You win some, you lose some: variation in bone growth, gain and loss across the skeleton.** P. BEAUCHESNE, S.C. AGARWAL.
- 7 **Mechanotransduction in bone: lessons from mice.** A. ROBLING.
- 8 **Distributions of secondary osteon collagen/lamellar morphotypes are important in avoiding stress fractures: A new hypothesis for the etiology of stress fractures.** J.G. SKEDROS.
- 9 **Fracture Resistance in the Human Rib: Contributions of Cross-Sectional Geometry.** A.M. AGNEW, E. MISICKA, M.M. MURACH, V.M. DOMINGUEZ, T.P. GOCHA.
- 10 **Longitudinal variation of osteon circularity in three-dimensional reconstructions of Haversian networks.** I. MAGGIANO, C. MAGGIANO, J. CLEMENT, D. THOMAS, D. COOPER.

### Session 36

#### **Primate Social Behavior II Contributed Poster Presentations**

*Chair: Monica L. Wakefield*

Acadia

- 1 **Visitor effects on Western Lowland Gorillas (*Gorilla gorilla gorilla*).** A. KIRWEN.
- 2 **Spatial Organization in Female Bonobos (*Pan paniscus*) Reflects Social Cohesion.** A.J. HICKMOTT, C.M. BRAND, K.J. BOOSE, F.J. WHITE.

## FRIDAY MORNING SESSIONS

- 3 Males in uniform: intra-individual pelage color variation is associated with social style in male macaques. A. VAN HORN, A.N. SPRIGGS, B.C. WILHELM, J.M. KAMILAR, B.J. BRADLEY.
- 4 Gorilla Social Dynamics: Only Heterosexual Relationships Impact Long-Term Stress in Captive Western Lowland Gorillas (*Gorilla gorilla gorilla*). A.N. EDES, B.A. WOLFE, D.E. CREWS.
- 5 The Use of Color Cues in Within-group Competition over Food Resources by Tufted Capuchin Monkeys. A. COLOSIMO, C.J. SCARRY.
- 6 Should I stay or should I go? Using Hinde's proximity index to understand changing social relationships in Hylobatid groups as offspring mature. A.C. SHELDON, G. SKOLLAR.
- 7 Group membership, individual identity, and sex encoded in *Saguinus imperator* long calls. E.E. ROBAKIS, M. WATSA, G. ERKENSWICK.
- 8 Methodological Considerations for Measuring Female Chimpanzee Social Relationships. M.L. WAKEFIELD, A.J. HICKMOTT, L.M. MEADOR, S.J. AMSLER, K.D. WILD.
- 9 Nearly naked apes: A survey of hair plucking among captive bonobos (*Pan paniscus*). L.F. MARCHANT, C.M. BRAND.
- 10 Male Reproductive Strategies in the Context of Female Defense Polygyny: An Agent-Based Model. K.N. CROUSE, C.M. MILLER.
- 11 *Propithecus* as Prey: vigilance and Behavioral Changes in *Propithecus edwardsi* After a Perceived Predator Threat. A.R. LAMB, P. WRIGHT.
- 12 Individual Social Strategies Vary in Relation to Network Position Among Sub-Adult Male Long-Tailed Macaques. J.V. PETERSON, A. FUENTES.
- 13 Oxytocin (OT) and Arginine-Vasopressin (AVP) Cell Bodies and Fibers in the Social Behavioral Neural Network in Rhesus Macaques, Chimpanzees, and Humans. C. ROGERS, A.P. ROSS, J. DOOYEMA, M. CREE, S.P. SAHU, E. SIEGEL, E.G. STOPA, J.K. RILLING, H.E. ALBERS, L.J. YOUNG, T.M. PREUSS.

## Session 37

### Human Biology and Genetics II

#### Contributed Poster Presentations

Chair: Kirsten A. Zieseimer

Acadia

- 1 Recovery of ancient DNA from Upper Nubian skeletal remains. A.M. BREIDENSTEIN, A. BOUWMAN, G.E. ZOELLER, G. EMBERLING, F. RUEHLI, A.W. BIGHAM.
- 2 Interpreting the Penutian migration through Genetics: Ancient human DNA analysis from Central California. F.A. VILLANEVA, C. MONROE, R. CAMBRA, A. LEVENTHAL.
- 3 Paleogenomic investigations of human remains from Rapa Nui. L. FEHREN-SCHMITZ, K.M. HARKINS, C.L. JARMAN.
- 4 A new method for assessing postmortem DNA damage from ancient remains. K.M. HARKINS, J.D. KAPP, L. FEHREN-SCHMITZ, R.E. GREEN.
- 5 Comparison of Five Different DNA Extraction Methods for Reconstructing Ancient Gut Microbiomes from Coprolites. R.W. HAGAN, C. HOFMAN, K. REINHARD, K. SANKARANARAYANANN, C. WARINNER.
- 6 Comparative Sub-Regional Population Structure within South America using MtDNA and Y-Chromosome DNA. B.C. HERRERA, M. HUBBE.
- 7 Investigating the genetic impacts of Spanish missionization on the Gule of St. Catherines Island, Georgia. L.C. SPRINGS, C.S. LARSEN, D.H. THOMAS, A.M. SEMON, D.A. BOLNICK.
- 8 Genetic Diversity in the Dominican Republic: Implications for the Population and Demographic History of Hispaniola. E.R. OAKLEY, R. PAULINO-RAMIREZ, B. VEGA, M.G. VILAR, A. MENCIA-RIPLEY, S. GUERRERO-MARTINEZ, A. BENITEZ, T.G. SCHURR.
- 9 History of Human Population Diversity Studies in Central America. N.F. BALDI, R. BARRANTES.
- 10 Comparison of southwestern US Hispanic populations to Mexican Hispanic populations using immunoglobulin haplotypes. M.S. SCHANFIELD.
- 11 Insights into the Cahokian Sphere of Influence through Ancient DNA Evidence. J.L. HARRISON, F.A. KAESTLE.
- 12 Y STR Variation in Six Garífuna Villages on the Honduran Coast. K.G. BEATY, E. HERRERA-PAZ, N. BALDI-SALAS, N. BRACCI, M. MATAMOROS, M.H. CRAWFORD, R. ROY.

## FRIDAY MORNING SESSIONS

- 13 The effect of mobility and modernization on co-residence patterns in Batek hunter-gatherers: a longitudinal analysis. T.S. KRAFT, V.V. VENKATARAMAN, K.M. ENDICOTT.
- 14 Cultural and biological pathways of transmission among post-contact Native Americans on the High Plains. S.J. LYCETT, N. VON CRAMON-TAUBADEL.
- 15 Three-dimensional analysis of facial aging and asymmetry from juvenile to old age. J. VELEMÍNSKÁ, E. HOFFMANNOVÁ, J. KOUDELOVÁ, J. DUPEJ.
- 16 Age-progression and age-regression face modelling in Czech girls from 6 to 15 years based on three-dimensional longitudinal data. E. HOFFMANNOVA, J. KOUDELOVÁ, J. DUPEJ, J. VELEMÍNSKÁ.
- 17 Neonatal hair cortisol in rural Gambian infants. S. FARDI, S. DRAMMEH, A. DOEL, A.M. PRENTICE, S.E. MOORE, R.M. BERNSTEIN.
- 18 Age- and Testosterone-dependent Changes in Facial Asymmetry among Adolescent Bolivian Males and Females. C.R. HODGES-SIMEON, K.N. HANSON SOBRASKE, K. STEINHILBER, M. GURVEN, S.J. GAULIN.
- 19 Postnatal Neuron increase in the Human Amygdala is more Extensive than in other Hominids. N. BARGER, M.V. VARGAS, T.A. AVINO, K. SEMENDEFERI, C.M. SCHUMANN.
- 20 Greater variability in within-section cortical thickness among men relative to women and its effects on the accuracy of periosteally-derived cross-sectional geometry estimates. A.A. MACINTOSH, C.N. SHAW, T.M. RYAN, J.T. STOCK.
- 21 Breast milk macronutrient content in rural West African mothers is impacted by season of infant birth and maternal energy balance. M.A. GRUCA, S.E. MOORE, M.K. DARBOE, A.M. PRENTICE, R.M. BERNSTEIN.
- 22 An Evolutionary Perspective on Elective Cesarean Section. K.R. ROSENBERG, W.R. TREVATHAN.
- 23 Growth and reproduction in adult women: understanding the interactions of evolution and culture in American and rural Brazilian populations. A.C. RIVARA, S.G. PAIVA.
- 24 First case of cd39  $\beta$ -thalassemia found in a Sardinian man from 2000 years ago. C. VIGANÒ, G. AKGÜL, F. RÜHLI, A. BOUWMAN.
- 25 Whole human genome enrichment on dental calculus. K.A. ZIESEMER, J. RAMOS MADRIGAL, A.E. MANN, K. SANKARANARAYANAN, C. WARINNER, C. HOFMAN, H. SCHROEDER.
- 26 Using Mitogenomes to Understand Dog Population History in the Americas. K.E. WITT, R.S. MALHI.
- 27 The Distribution of CFTR Haplotypes in Brazilian Quilombos as a Consequence of History. C. CARVALHO GONTIJO, D. MORAES, C.X. DE CARVALHO, E.M. COELHO, C.T. MENDES-JUNIOR, G. FEIJÓ, M. KLAUTAU-GUIMARÃES, S.F. DE OLIVEIRA.
- 28 Placentophagy's Effects on Postpartum Maternal Affect, Health, and Recovery. S.M. YOUNG, L.K. GRYDER, C. CROSS, D. ZAVA, D.W. KIMBALL, D.C. BENYSHEK.
- 29 Community Support Buffers Psychosocial Stress in Mothers of Infants. B.N. EVANS, B.L. TURNER.

### Session 38

#### Functional Anatomy: Ontogeny

##### Contributed Poster Presentations

*Chair: Jacqueline Runestad Connour*

Acadia

- 1 A 'Hypophysis' to Test: Comparative Aspects of Pituitary Gland Anatomy and its usefulness for Reconstructing Hominin Life History. A. MCGROSKY, J.M. KAMILAR, S.R. TECOT, G.T. SCHWARTZ.
- 2 Functional morphology of the occipital condyles in anthropoids. A.C. NISHIMURA, P.J. FERNÁNDEZ, J.S. GUERRA, G.A. RUSSO.
- 3 A three-dimensional geometric morphometric evaluation of shape variation in the hybrid baboon cranium. T.B. RITZMAN, D.C. KATZ, K.E. WILLMORE, J. CHEVERUD, J. ROGERS, R.R. ACKERMANN.
- 4 Integration of the Anthropoid Skull: An Ontogenetic Perspective with Insights into Jaw Fusion. R.P. KNIGGE.
- 5 Spandrels and Functional Matrices: the Ontogenetic Basis for Primate Postorbital Septation. V.B. DELEON, A.L. ROSENBERGER, T.D. SMITH.
- 6 Relationship of Turbinal Surface Area and Nasal Cavity Volume in Primates. M.C. MARTELL, T.D. SMITH, V.B. DELEON.
- 7 Energetics of the Nasal cavity: The impact of Total Energy Expenditure on Cranial Airway Morphology. V.N. MASON, R.S. SCOTT, S. CACHEL.
- 8 A novel method for estimating ancestral ontogenetic trajectories of shape change using cercopithecine crania as a test case. E.A. SIMONS, S.R. FROST, M. SINGLETON.
- 9 Variation in osteon size in the cercopithecoid femur and its implications for bone fracture toughness. S.E. LAD, W. MCGRAW, D.J. DAEGLING.
- 10 Cancellous bone density in age-sorted atelines. J. RUNESTAD CONNOUR, K.M. NIDA, K.E. GLANDER.

## FRIDAY MORNING SESSIONS

- 11 Ontogenetic changes in trabecular architecture: A pilot study of chimpanzee (*Pan troglodytes*) manual and pedal elements. A.J. RAGNI, N. WEBB, W. HARCOURT-SMITH.
- 12 Population-level Ontogenetic Variation in *Gorilla* and *Pan*. J.S. MASSEY, K.P. MCNULTY.
- 13 Geometric Morphometrics of the Neonatal Pelvis in Strepsirrhine Primates. S.M. ZALESKI, T.D. SMITH, J.W. YOUNG, V.B. DELEON.
- 14 Ontogeny of Morphological Variation in the Talar Trochlea of *Gorilla*. L.M. FATICA, K. TURLEY, A. MUDAKIKWA, M.R. CRANFIELD, T.S. STOINSKI, S.C. MCFARLIN, S. ALMÉCIJA.
- 15 Skeletal aging in mountain gorillas. C.B. RUFF, M. BURGESS, A. MUDAKIKWA, S. MCFARLIN.
- 16 Trauma, Growth, and Death: An analysis of *Gorilla gorilla* life history from specimens at the Yale University Peabody Museum of Natural History. R.T. MCRAE, G.P. ARONSEN.
- 17 Facial fluctuating asymmetry in wild Virunga mountain gorillas (*Gorilla beringei beringei*). A.B. ERIKSEN, K. MCGRATH, A. GÓMEZ-ROBLES, L. SCHROEDER, J.S. MASSEY, T.G. BROMAGE, A. MUDAKIKWA, T.S. STOINSKI, M.R. CRANFIELD, M.W. TOCHERI, S.C. MCFARLIN, N. VON CRAMON-TAUBADEL.
- 18 Possible idiopathic scoliosis in a bonobo. C.A. KIRCHHOFF, H.S. LLOYD.
- 19 Growth of the Catarrhine Ectotympanic Tube. E.E. FRICANO, V.B. DELEON.
- 20 Muscle proportions and body composition in an infant gorilla. D. BOLTER, C. UNDERWOOD, A. ZIHLMAN.
- 21 Middle phalanx morphology reflects postural differences of primate grooming and nail-bearing digits. S.A. MAIOLINO.
- 22 Hyoid Proportions, Growth, and Spatial Placement in Non-Human Primates. A.S. CUNNINGHAM, T.D. SMITH, V. BURKE DELEON.

## Session 39

### Primates: Methods and Morphology

#### Contributed Poster Presentations

Chair: Julia Arias-Martorell

Acadia

- 1 A novel approach to anatomical complexity: Random Forest Analysis applied to jaw morphology in Homininae. J. LAWRENCE, M. SÓSKUTHY.
- 2 Correlated Responses to Selection among Elements of the Cranium and Appendicular Skeleton between Large-Bodied and Small-Bodied Tamarins. E.R. AGOSTO, B.M. AUERBACH.
- 3 A macroevolutionary perspective on human gut proportions. E.K. BOYLE, S. ALMÉCIJA.
- 4 A 2D Geometric Morphometric Analysis of Cercopithecoid Mandibular Symphysis Outline Shape: Implications for Taxonomy and Systematics. C.M. KIMOCK.
- 5 Distinguishing locomotor adaptation of non-human primates and hominoids using ulnar diaphyseal curvature. C.E. TAYLOR, Y. HAILE-SELASSIE.
- 6 Trabecular architecture of the hominoid humerus. J. ARIAS-MARTORELL, R. DAVENPORT, T.L. KIVELL, M.M. SKINNER.
- 7 Brain size as an evolutionary constraint on facial form. A. PETTIT, B. VILLMOARE.
- 8 Evolutionary Implications of Variability and Rates of Change in the Primate Lumbosacral Plexus. B.M. SHEARER.
- 9 Looking beyond Phalangeal Length and Curvature: Functional Correlation between Manual Phalangeal Articular and Collateral Ligamentous Morphology and Anthropoid Locomotor Adaptations. K.M. WILES, M.W. TOCHERI, A.S. DEANE.
- 10 Combining 3DGM analyses from multiple anatomical regions improves phylogenetic interpretations of phenetic data in Platyrrhini. J.T. GLADMAN, G.S. YAPUNCICH, S.B. COOKE.
- 11 Morphometric analysis of the chimpanzee maxillary and ethmoid sinuses. S.B. BOREN, D. DURAND.
- 12 Testing Hypotheses for the Embryonic Origins of Primate Neocortical Expansion. A. KRISHNAMURTHY, A.C. HALLEY, T.W. DEACON.
- 13 Paleobiogeography of the Colobinae. S. CARNATION.
- 14 Canine Tooth Robusticity mitigates Stress in the Jaw. Z.S. KLUKKERT.

## FRIDAY MORNING SESSIONS

### Session 40

#### **Forensic Anthropology and Bioarchaeology: Collections, Ancestry, and Age at Death**

##### **Contributed Poster Presentations**

*Chair: Kyra Stull*

Acadia

- 1 The Shallow Biohistory of Recently-acquired Skeletal Material by the Louisiana Department of Justice. C.L. HALLING, R.M. SEIDEMANN.
- 2 Skull shapes, maps and museum collections: Representing modern human cranial variation. M. FRIESS, M. GALLAND.
- 3 Using sociological segregation indices to reintroduce geographical relationships in anatomical skeletal collections. A.C. ZIMMER.
- 4 Humans of Anthropology Teaching Collections: Life-histories of Body Donors. O. LYSA, K. PECHENKINA.
- 5 Are virtual bones, derived from clinical CT scans, a precise source for a virtual skeletal reference database? K.L. COLMAN, J.G. DOBBE, K.E. STULL, J.M. RUIJTER, R. OOSTRA, R.R. VAN RIJN, A.E. VAN DER MERWE, H.H. DE BOER, G.J. STREEKSTRA.
- 6 3D Modeling of Skeletal Remains Using Agisoft Photoscan: Best practices for Field Data Collection. J.E. KAISER, A.M. DAMARANY.
- 7 Documenting Burials and Mortuary Context in the Field using 3D Technology. T. PARSONS, R.P. HARROD.
- 8 3D reconstructions of cortical canal network is an efficient method to differentiate human from animal fragmentary bones. C. RITTEMARD, O. DUTOUR, H. COQUEUGNIOT.
- 9 Three-dimensional Reconstruction of Vascular Pore Networks in the Human Rib from Two-dimensional Serial Sections. M.E. COLE, S.D. STOUT.
- 10 Measuring digit ratios from 2D hand scans versus negative handprints: Implications for archeology. A.P. GREMBA, C. TORGALSKI, S. WEINBERG.
- 11 Teaching Forensics in the Classroom: Considerations for Ancestry Determination in Educational Settings. A.R. DZUBAK, C. CHEVERKO.
- 12 Accuracy Rates of Ancestry Estimation by Forensic Anthropologists Using Identified Forensic Cases. R.M. THOMAS, C. PARKS, A. RICHARD.
- 13 Effect of age on nonmetric cranial traits for sex estimation in subadults and adults. K.M. LESCIOTTO, L.J. DOERSHUK.
- 14 The Effect of Age on Nasal Aperture Shape in Humans. A. VARVARES, V.B. DELEON.
- 15 Understanding (mis)classification trends of Hispanics in Fordisc 3.1: Incorporating cranial morphology, microgeographic origin, and admixture proportions for interpretation. C.E. HUGHES, B. DUDZIK, B.F. ALGEE-HEWITT.
- 16 Estimating ancestry in undocumented migrants along the south Texas border using dental morphological traits: a test of Edgar's method. C.M. CLEMMONS, M. SPRADLEY, D.J. WESCOTT.
- 17 Estimating ancestry of patients from the Colorado State Insane Asylum from 1879-1899 using geometric morphometric software. R. PEREZ, A.H. ROSS.
- 18 Understanding the Degree of Craniometric Variation in South Texas Migrants. C.P. MCDANELD, T.P. GOCHA, C.C. SIEGERT, R.M. STRAND, L.E. BAKER, M. SPRADLEY.
- 19 Cranial growth in six- to eight-year-old humans: comparison of standard metric and 3D coordinate data. D.E. BECKER, N.A. CASTELLON-HINKLE, L.E. CIRILLO, R.S. JABBOUR, G.D. RICHARDS.
- 20 A critical review and classification of juvenile age estimation methods. L.K. CORRON, F. MARCHAL, S. CONDEMI, P. ADALIAN.
- 21 Estimating age at death in subadults from metaphyseal width of lower limb longs bones. C. ROSSETTI, M. LICATA, G. ARMOCIDA, A. VERZELETTI, A. TOSI.
- 22 Left or Right Pubic Symphysis: Asymmetry Analysis of Age-at-Death Estimation Using 3D Laser Scans and Computational Algorithms. D.K. STOYANOVA, B.F. ALGEE-HEWITT, J. KIM, D.E. SLICE.
- 23 Use of the structured light scanner David SLS-2 for recording auricular surface in 3D and implications for age at death assessment. J. BRŮŽEK, J. DUPEJ, A. KOTĚROVÁ, R. RMOUTILOVÁ, J. VELEMÍNSKÁ.
- 24 The effects of epiphyseal fusion asymmetry on juvenile age estimation. K.E. STULL, L. CORRON.
- 25 Estimation of ancestry in non-adults. A.L. SZEN.
- 26 Cortical Thickness as a Supplement to Osteon Population Density to Estimate Age at Death. T.P. GOCHA, M.M. MURACH, A.M. AGNEW.
- 27 A retrospective study of age estimation method performance on positively identified forensic cases. C.C. CATALDO-RAMIREZ, M.J. RUE, H.M. GARVIN.
- 28 Skeletal Midshaft Diameters as Estimators of Age at Death in Subadults. M.T. KETCHUM, S. NAWROCKI.
- 29 Quantitative assessment of age-related topographic changes in the pubic symphysis. M.K. STOCK, P.E. MORSE, C. VILLA.

## FRIDAY MORNING SESSIONS

- 30 **A Test of Fazekas and Kósa (1978) Fetal Aging Standards using Ultrasound Data.** J.A. CONLEY, S. OUSLEY.
- 31 **The effect of pathology on bone microstructure: implications for histological age estimation.** C.E. LILL, J.G. GARCIA-DONAS, R.R. PAINE, B. XHEMALI, E.F. KRANIOTI.
- 32 **Histological age estimation on two Mediterranean Populations: A validation study of four existing methodologies.** J. GARCÍA-DONAS, A.R. SCHOLL, A. DALTON, R.R. PAINE, E.F. KRANIOTI.
- 33 **Revised Transition Analysis: Validation on a Historical Sample and the First Archaeological Application of the New Procedure.** S.M. GETZ, G.R. MILNER, J.L. BOLDSSEN.
- 34 **Data standardization in anthropology: Curation and access.** A.E. KENDELL, N.L. GESKE.
- 35 **Data standardization in anthropology: methods and best practice.** N.L. GESKE, A.E. KENDELL.
- 36 **Experiences in the application and attendance of human skeletal biology graduate programs.** N.V. PASSALACQUA, H.M. GARVIN.
- 37 **Application and Accuracy of 3D Scanned Postcranial Bones.** V. HARRINGTON, H. MCKILLOP.
- 38 **A quantitative analysis of iodine stained CT (DiceCT) measurements in physical and digital dissection.** J. LEVY, P.J. LEWIS, A. HARTSTONE-ROSE.
- 39 **The Statistics of Tiny Samples: The Utility of ACTUS, an Alternative Method of Contingency Table Analysis Using Simulation, in Human Skeletal Biology.** V.H. ESTABROOK, D.A. PROSSER.
- 40 **Big Classes, Small Budgets, and Osteometric Lab Equipment: Is cost Commensurate with Quality?** L.L. TAYLOR, M. FARALDO, G.A. CARDENAS.
- 41 **Cortical Bone Dynamics and Skeletal Age at Death Assessed from Human Femoral Cortical Histomorphology.** R.A. WALKER.
- 42 **Trabecular Bone Morphometrics: A Methodological Appraisal of Software Applications.** N.M. WEBB, Y. HU, X. GUO.
- 43 **Dental Crown Morphological Variation at the Boothill Burial Ground: Ancestry Estimation Using rASUDAS.** J.D. SYKES, K.A. VEROSTICK, E.H. KIMMERLE, J. BETHARD.
- 44 **Alternative instrument bags: assessing the accuracy and precision of the iGaging 8" Digital Outside Calipers.** J.M. BERGER, K.E. FAILLACE.

# FRIDAY, AFTERNOON SESSIONS

## Session 41

### **Beyond Visibility: How Academic Diversity is Transforming Scientific Knowledge**

#### **Invited Podium Symposium**

*Organizers/Chairs: Deborah A. Bolnick, Rick W.A. Smith  
Balcony I/J*

In recent years the field of biological anthropology and the AAPA have taken center stage in national debates concerning sexual harassment, the need for greater integrity and safety in the field and workplace, and sex and gender equality in the sciences. The AAPA has also seen unprecedented efforts to increase diversity in the discipline, including the Committee on Diversity's Undergraduate Symposium, the Increasing Diversity in Evolutionary Anthropological Sciences (IDEAS) workshop, and the formation of the GAYAPA interest group, among others. These developments have been important for increasing the inclusion of underrepresented groups in science and are crucial to broadening access and increasing justice within biological anthropology. However, while strides have been made towards improving visibility for underrepresented groups and their concerns in the field, less consideration has been given to the intellectual contributions that diversification brings. Such diversity includes new kinds of questions and theoretical perspectives, new approaches to research design and ethics, new insights and interpretations of data — leading to the production of new knowledge within biological anthropology and the sciences more generally. In this symposium we draw on the voices and insights of scholars from within biological anthropology and beyond to highlight how scientists from diverse backgrounds are producing new kinds of knowledge about humans and non-humans, the connections between bodies, biology, and culture, and the politics and practice of science. We show that diversity is not just a question of visibility and representation; it is also about making a new and vital science together. This session will explore how our collective efforts to change “who we are” also involves expanding and reconstituting “what we know”.

- 2:30 **Alterity and Anthropometrics: Blackness, Vulnerability, and Post-Colonial Identities in Biological Anthropology.** R.G. NELSON.
- 2:45 **Land of Milk and Honey: Infiltrating Academia to Pursue Overlooked Topics.** K. HINDE.
- 3:00 **Belief(s), Identity, and Experience: Navigating Multiple Influences on Knowing in Biological Anthropology.** A. FUENTES.
- 3:15 **How subjectivity strengthens research: Developing new approaches to anthropological genetics in the Pacific Northwest.** A.C. BADER, R.S. MALHI.

- 3:30 **Marginal perspectives within hegemonic spaces: the marronage of genomic technologies.** J. BENN TORRES.
- 3:45 **Undisciplining Desire: Bisexual and Queer Approaches to Science.** S.M. ARCHER, T. VILLASEÑOR-MARCHAL, R.W. SMITH.
- 4:00 **The Coloniality of Philosophies of Biology.** S. MCLEAN.
- 4:15 **Dead end evolutionary lineage, says the White man: the evolution of *Homo erectus* and *Homo sapiens* in Asia.** S.G. ATHREYA.
- 4:30 **Queer developments: LGBTQIA perspectives on ontogeny, growth and development, and ranges of variation in human and nonhuman primates.** C.A. SCHMITT, C.M. ASTORINO, S.L. MEREDITH.
- 4:45 **How social justice perspectives expose hidden exclusions in science.** D.N. LEE, K.B. CLANCY.
- 5:00 **Minority Rules: Social Capital, Scientific Obligations, and the Struggle to Decolonize Biological Anthropology.** V.R. PÉREZ.
- 5:15 **Discussant: Alan H. Goodman.**
- 5:30 **Discussant: Kim TallBear.**

## Session 42

### **Signals in Evolutionary and Ecological Context**

#### **Invited Podium Symposium**

*Organizer/Chair: Michael P. Muehlenbein  
Bissonet*

Evolutionary signals are hypothesized to represent phenotypic traits that influence the behaviors of others. These signals develop through the mechanisms of natural and sexual selection, resulting from complex interactions between individuals within a variety of ecological contexts. Such traits have been studied extensively in a variety of taxa, with much recent work in human and nonhuman primates. The present symposium includes new and established experts in human and nonhuman primate signaling systems to review the present state of research on evolutionary signals in a variety of species across the order Primates (including humans, macaques, lemurs, and others). Drawing from concepts in sexual selection and life history theory, and a growing body of both field and laboratory observations and experiments, these presentations include discussion on skin and hair coloration, sexual swellings, pheromones, body and face size and shape, vocalizations, physiological performance, and even religious rituals and parenting behaviors as signals. Discussion is focused primarily within the context of mate selection (signaling between the sexes), although social status (signaling within the sexes) is also

## FRIDAY AFTERNOON SESSIONS

considered. The potential costs behind these 'viability-indicators' are reviewed, especially the immunological and physiological correlates of coloration and other physical traits.

- 2:30 **Co-evolution of Male and Female Primate Sexual Signals, the Example of Crested Macaques.** A. ENGELHARDT.
- 2:45 **Variation in Lemur Color Vision across Species, Populations and Habitats: Implications for Signal Evolution.** R.L. JACOBS, T.S. MACFIE, J.M. KAMILAR, A.N. SPRIGGS, A.L. BADEN, T.L. MORELLI, M.T. IRWIN, R.R. LAWLER, J. PASTORINI, M. MAYOR, M.L. SAUTHER, R. LEI, R. CULLIGAN, M.T. HAWKINS, P.M. KAPPELER, P.C. WRIGHT, E.E. LOUIS JR, N.I. MUNDY, B.J. BRADLEY.
- 3:00 **Female and male rhesus macaque red skin coloration in evolutionary context.** C. DUBUC, J.P. HIGHAM.
- 3:15 **Is primate sexual coloration an accurate indicator of immune functions?** M.P. MUEHLENBEIN, S.P. PRALL, E.C. SHATTUCK, C.S. SPARKS, K.C. BAKER.
- 3:30 **How selection shapes primate major histocompatibility complex polymorphism.** L.A. KNAPP.
- 3:45 **Condition-dependent scent signals in strepsirrhine primates.** C.M. DREA.
- 4:00 **Are sexual swellings reliable indicators?** C.L. FITZPATRICK, J. ALTMANN, S.C. ALBERTS.
- 4:15 **Are human voices honest signals of condition?** D.A. PUTS.
- 4:30 **Sizing up Strangers: Sexual Selection and Vocal Signals in Male Geladas (*Theropithecus gelada*).** M.E. BENÍTEZ, T.J. BERGMAN, J.C. BEEHNER.
- 4:45 **Cardiovascular fitness as a signal of reproductive potential.** D. LONGMAN, J.C. WELLS, M.K. SURBEY, J.T. STOCK.
- 5:00 **Evidence for specialized processing of facial kinship cues.** L.M. DEBRUINE, E. TURNER, R. GORDON, B.C. JONES.
- 5:15 **What does women's facial attractiveness cue?** B.C. JONES, A.C. HAHN, C.I. FISHER, M. KANDRIK, H. WANG, C. HAN, L.M. DEBRUINE.
- 5:30 **Behaviors, Badges, Bans, and Babies: Religious Commitment Signaling and Unwed Motherhood in American Samoa.** C.D. LYNN, M.E. HOWELLS.
- 5:45 **Signaling human fathering potential.** P.B. GRAY.
- 6:00 **Discussant: Jo Setchell.**

## Session 43

### Human Skeletal Biology: Mobility, Isotopes, Diet

#### Contributed Podium Presentations

*Chair: Bethany L. Turner*

Studio 1/2/3

- 2:30 **Mobility and trabecular bone variation in the human foot.** J.P. SAERS, C.N. SHAW, T.M. RYAN, J.T. STOCK.
- 2:45 **Foot Muscle Size and Longitudinal Arch Biomechanics in a Minimally Shod, Non-industrial Human Population.** N.B. HOLOWKA, E.F. KOCH, M. RUIZ, I.J. WALLACE, D.E. LIEBERMAN.
- 3:00 **Femoral metaphyseal morphology as a predictor of locomotor behavior.** P.A. STAMOS, Z. ALEMSEGED, A.J. CHAUDHARI, T.D. WEAVER.
- 3:15 **Horticultural activity predicts later localized limb status in a contemporary pre-industrial population.** J. STIEGLITZ, B. TRUMBLE, H. KAPLAN, M. GURVEN.
- 3:30 **Roving Romans: Biomechanical and Fracture Evidence for Sex-related, Intensified Mobility at Vagnari, Italy.** R.J. GILMOUR, T.L. PROWSE, E. JURRIAANS, M.B. BRICKLEY.
- 3:45 **Paleomobility in the 5th century Mediterranean: Oxygen isotope analysis of soldiers from the Battles of Himera (480 BCE, 409 BCE).** K.L. REINBERGER, B. KYLE, P. FABBRI, S. VASSALLO, L.J. REITSEMA.
- 4:00 **Subsistence and mobility at Hellenistic New Halos, Greece: as reconstructed from stable carbon, nitrogen, oxygen and strontium isotope analysis.** H.A. SPARKES, S. GARVIE-LOK, M. HAAGSMA.
- 4:15 **Utilizing Isotope Analysis to Assess the Origins of Axis Combatants from World War II.** K.E. KOLPAN, I. HANSON, G. KAMENOV, J. KRIGBAUM.
- 4:30 **Early Spanish Colonialism in Northern Guatemala: Identifying Itza Mayas at the Mission San Bernabé using Strontium, Carbon, and Oxygen Isotope Assays and Biodistance Analyses.** C. FREIWALD, K. MILLER WOLF.
- 4:45 **Assessing Demographic Change From the Iron Age (7th – 4th c. B.C.E) through the Roman Period (1st – 3rd c. C.E.) in Southern Italy Using Isotope and Whole-Mitochondrial Genome Analysis.** M.V. EMERY, A.T. DUGGAN, H.P. SCHWARCZ, H.N. POINAR, T.L. PROWSE.
- 5:00 **Gender, ethnicity, and diet in the Late Intermediate Period, Colca Valley, Peru: A study of carbon and nitrogen isotope ratios from bone collagen.** M.C. VELASCO, T.A. TUNG.

## FRIDAY AFTERNOON SESSIONS

- 5:15 Isotopic analysis of pre-Columbian Groups from the Brazilian coast. M.Q. BASTOS, A. LESSA, R.V. SANTOS, C. RODRIGUES-CARVALHO.
- 5:30 Spanish Colonial Impacts on Foodways and Diet in the Zaña Valley of Peru: A Multi-Isotopic Reconstruction. B.L. TURNER, P. VANVALKENBURGH, B.J. SCHAEFER.
- 5:45 Stable Isotope Evidence for Salmon Consumption in the Prehistoric Sacramento Valley of California. E.J. BARTELINK, J. NELSON, D. FURLONG, S. KLINE, J. PRINCE-BUITENHUY, A. MACKINNON, F. BAYHAM.
- 6:00 Biological continuity over the transition to food production in Eastern Africa: human dental evidence from early pastoralists. E. SAWCHUK.
- 4:15 An Integrative Approach for Evaluating Rhesus Macaque Social Behavior: Whole Genome Sequencing Reveals Molecular Variation in a Suite of Neuroreceptors. M.J. MONTAGUE, N. SNYDER-MACKLER, S. MADLON-KAY, K.K. WATSON, L.J. BRENT, J.H. SKENE, J.E. HORVATH, M.L. PLATT.
- 4:30 An Evolutionary Perspective on the Contribution of Serotonergic Genetics to Health: Lessons from Rhesus Macaques. S.M. LARSON, A. RUIZ-LAMBIDES, J. HORVATH, A. ROBINSON, P. SKENE, M.L. PLATT, L.J. BRENT.
- 4:45 Mechanisms of convergent testis transcriptome evolution in primates. E. SAGLICAN, M. DONERTAS, R. ROHLFS, E. OZKURT, H. HU, R. NEME, B. ERDEM, P. KHAITOVICH, M. SOMEL.
- 5:00 Relationship between Reproductive status and Gut Microbial Community Composition in White-faced Capuchins (*Cebus capucinus*). E.K. MALLOTT, P.A. GARBER, R.S. MALHI, K.R. AMATO.
- 5:15 Evidence for elevated diversity in genes linked to facial diversity in apes supports the hypothesis that individual facial recognition is important across hominoids. M.E. STEIPER, N.T. GRUBE, C.M. GAGNON.
- 5:30 Genomic basis for fatal *Toxoplasma gondii* infection in primates. Y. SUAREZ, S. GUNASEKERA, N. VALIZADEGAN, K. VAN ETTEN, W.H. WITOLA, J. LINDE, J.F. BRINKWORTH.
- 5:45 Genomic analyses of *Mycobacterium leprae* strains from naturally infected nonhuman primates. T.P. HONAP, L. PFISTER, A.C. STONE.

### Session 44

#### Primate Genetics and Adaptation

##### Contributed Podium Presentations

Chair: C. Eduardo Amorim

Studio 7/8/9

- 2:30 An unsteady molecular clock in primates. P. MOORJANI\*, C.G. AMORIM\*, P. ARNDT, M. PRZEWORSKI.
- 2:45 Population genomics disentangles taxonomic relationships and identifies ancient hybridization in the genus *Chlorocebus*. H. SVARDAL, A. JASINSKA, C.A. SCHMITT, Y. HUANG, G. WEINSTOCK, J.P. GROBLER, R.K. WILSON, W.C. WARREN, N.B. FREIMER, M. NORDBERG, T.R. TURNER.
- 3:00 Tarsier Phylogenetic Inference using Museum Skin Samples. L.C. MATTHEWS.
- 3:15 Chimpanzees of the past: Full mitochondrial genomes from *Pan troglodytes schweinfurthii* skeletons from Gombe National Park. A.T. OZGA, M.A. NIEVES-COLON, R. NOCKERTS, M.L. WILSON, I.C. GILBY, A. PUSEY, A.C. STONE.
- 3:30 Evidence of frequent hybridization in guenons (tribe Cercopithecini) from phylogeny with genome-wide markers. C.M. BERGEY, A.S. BURRELL, A.J. TOSI.
- 3:45 Two-Way Anthropogenic Hybridization between Invasive *Callithrix jacchus* and *C. penicillata* with Endemic *C. aurita*: A Threat to Marmoset Conservation. R.S. CARVALHO, J. MALUKIEWICZ, A.M. OLIVEIRA, D.G. PEREIRA, S. LOIOLA, E.F. CARVALHO, D.A. SILVA, H.G. BERGALLO.
- 4:00 A phylogeny of the *CHIA* gene in the context of insectivory. M.C. JANIAK, M.E. CHANEY, A.J. TOSI.

### Session 45

#### The Evolution of Form and Function in the Hominin Pelvis

##### Invited Poster Symposium

Organizers/Chairs: Karen L. Baab, Ashley S. Hammond, Matthew O'Neil

Balcony K

The pelvis conveys information about ape and hominin paleobiology, including phylogenetic history, body size and shape, development and locomotor capabilities. The past decade has seen a rapid increase in the number of hominin fossil pelvic remains, which has expanded our knowledge about pelvic evolution, while simultaneously raising many new and important questions. This new material has led researchers to reconsider long-standing ideas about the *Pan-Homo* last common ancestor, the earliest hominins and the origins of bipedalism (*Ardipithecus ramidus*), raised new questions about locomotor capabilities in

## FRIDAY AFTERNOON SESSIONS

australopiths and early *Homo* (e.g. *Australopithecus sediba*), and ignited new debates about size, shape and adaptation in *Homo erectus* (Gona pelvis). Recent work has also highlighted both stasis and mosaicism in pelvis evolution during the last 500,000 years of hominin evolution (*H. floresiensis*, mid-Pleistocene *Homo*), and has generated new ideas about the relative role of neutral genetic evolution and climate-driven selection in shaping modern human pelvic variation. This symposium will explore how integrative methodologies and new data can address questions presented by the more complete paleontological record for the pelvis. Contributors use methods as diverse as functional genomics, experimental biomechanics, musculoskeletal modeling, 3D morphometrics, comparative analyses and population genetics to explore morphological variation and the underlying factors driving this variation. A particular focus will be paid to pelvic remains described in the past decade. This symposium brings together diverse analytical approaches to better trace the key modifications in pelvis size and shape throughout hominin evolution, as well as provide new insights into the functional implications of these modifications.

3:00 Individual poster presentations and discussion led by Carol V. Ward.

- 1 The evolution of the human pelvis: A developmental genetics and functional genomics perspective. M. YOUNG, E. JAGODA, H. DINGWALL, T.D. CAPELLINI.
- 2 Developmental Perspectives on the Hominid Sacroiliac Complex. A.L. MACHNICKI, L.B. SPURLOCK, S.M. HRYCAJ, D.M. WELLIK, C. LOVEJOY, P.L. RENO.
- 3 Pelvic height, lumbar entrapment, and their effects on upper body stability during bipedalism. N.E. THOMPSON, M.C. O'NEILL, B. DEMES.
- 4 Pelvis shape, lumbar column length and the origin of the hominin walking stride. M.C. O'NEILL, N. OGIHARA, M. NAKATSUKASA, B. DEMES, N.E. THOMPSON, B.R. UMBERGER.
- 5 Mechanics of Hip Extension Characterize Arboreal-Terrestrial Trade-offs in Hominin Evolution. E.E. KOZMA, N.M. WEBB, W.E. HARCOURT-SMITH, D.A. RAICHLEN, K. D'AOÛT, M.H. BROWN, E. FINESTONE, S.R. ROSS, P. AERTS, H. PONTZER.
- 6 Defining Lateral Iliac Flare in Hominins. C. VANSICKLE.
- 7 Functional analysis of lower ilium shape and robusticity in Plio-Pleistocene hominins. K.L. LEWTON.
- 8 The functional significance of iliac buttressing in the genus *Homo*. S.E. CHURCHILL.
- 9 Comparative Morphometric Analysis and Digital Reconstruction of the *Homo floresiensis* Pelvis. K.L. BAAB, M.C. O'NEILL, A.S. HAMMOND, W.L. JUNGERS.
- 10 The middle Pleistocene human pelvis: a comparison across Eurasia. A. BONMATÍ, K. ROSENBERG, J. ARSUAGA, L. ZUNÉ.
- 11 Omo-Kibish pelvic morphology and implications for body form in the earliest modern humans. A.S. HAMMOND, D.F. ROYER, J.G. FLEAGLE.
- 12 Modern Variation in the Shape of the Birth Canal and the Effects of Climate and Population History. L. BETTI, A. MANICA.

### Session 46

#### The Axial Skeleton: Morphology, Function, and Pathology of the Spine and Thorax in Hominoid Evolution

##### Invited Poster Symposium

Organizers/Chairs: Ella Been, Alon Barash

Studio 4/5

The vertebral spine and the thorax are vital for existence. Their main role is to protect the spinal cord, the cardiovascular and respiratory systems as well as parts of the digestive tract. The axial skeleton with its muscles and joints provides stability for the attachment of the head and limbs and at the same time enables the mobility required for breathing and for locomotion. Despite its great importance the axial skeleton is often overlooked by researchers mostly because: a) vertebrae and ribs are fragile in nature, which makes their fossilization a rare event; b) they are metameric (seriated and repeated elements) that make their anatomical determination and thus, their subsequent study difficult; and c) the plethora of bones and joints involved in every movement or function of the axial skeleton makes the reconstruction of posture, breathing mechanics and locomotion extremely difficult. It is well established that the axial skeleton has changed dramatically during human evolution. Spinal curvatures, spinal load transmission and thoracic shape of bipedal humans are derived among hominoids. Yet, there are many debates as to how and when these changes occurred and what their functional and pathological implications are. In recent years, renewed interest arose in the axial skeleton. New and exciting findings mostly from Europe and Africa as well as new methods for reconstructing the spine and thorax have been introduced to the research community. Gait analysis of primates also adds to our understanding of the axial skeleton. This symposium explores the new models and new data, including recent fossil, morphological, biomechanical, and theoretical advances regarding the axial skeleton.

## FRIDAY AFTERNOON SESSIONS

3:00 Individual poster presentations.

5:00 Discussants: Liza J. Shapiro and Ella Been.

- 1 Intraspecific variation in hominoid vertebral morphology: effects of column position and locomotor adaptation. L.J. SHAPIRO, A.D. KEMP.
- 2 Total numbers of vertebrae clarify the ancestral vertebral formula of African apes and humans. S.A. WILLIAMS, D. PILBEAM.
- 3 The Evolution of Foramen Magnum Position and Orientation in Anthropoids. G.A. RUSSO, E. KIRK, J.S. GUERRA, J.B. SMAERS.
- 4 Functional inferences from vertebral morphology and torso shape in anthropoids. E.R. MIDDLETON, C.V. WARD.
- 5 A comparative and ontogenetic analysis of zygapophyseal facets along the thoracolumbar transition in apes and humans. T.K. NALLEY, J. WOOD, C.V. WARD.
- 6 How did early hominins hold their heads? New evidence on head posture from the australopith cervical spine. M.R. MEYER, S.A. WILLIAMS.
- 7 Geometric morphometrics of hominoid thoraces and its bearing for reconstructing the ribcage of *H. naledi*. M. BASTIR, D. GARCÍA-MARTÍNEZ, S.A. WILLIAMS, M.R. MEYER, S. NALLA, P. SCHMID, A. BARASH, M. OISHI, N. OGIHARA, S.E. CHURCHILL, J. HAWKS, L.R. BERGER.
- 8 The vertebral column of the Gran Dolina-TD6 and Sima de los Huesos hominins: new remains and new results. A. GÓMEZ-OLIVENCIA, J. ARSUAGA, J. BERMÚDEZ DE CASTRO, E. CARBONELL.
- 9 The vertebral column of La Chapelle-aux Saints: the evidence of spinal osteoarthritis for Neanderthal spinal curvature. M. HAEUSLER, C. FORNAI, N. FRATER, N. BONNEAU.
- 10 Reconstruction of the spinal curvatures in hominins, where do we stand? E. BEEN, A. GÓMEZ-OLIVENCIA, A. BARASH.
- 11 Lordosis variability and shock attenuation in the hominin lumbar spine. E.R. CASTILLO, D.E. LIEBERMAN.
- 12 Sexual dimorphism of lumbar lordosis: a case for joint laxity. J.F. BAILEY, E. BEEN, P.A. KRAMER.
- 13 Bilateral Variation in Human Lumbar Zygapophyses. K. WHITCOME.

## Session 47

### Biological Investigations of Nomads: Developments and Innovations

#### Invited Poster Symposium

Organizers/Chairs: Selin E. Nugent, Mark Hubbe

Studio 6

Nomadic people have historically been marginalized when compared to more sedentary populations. Nomads were frequently represented at the periphery of major developments in human history, such as cities, states, and empires, while present-day nomads face political and economic pressures that threaten their mobile lifestyles. However, mobility has characterized the vast majority of our history as a species, thus understanding the nature of nomadic lifestyles and their relationships with other populations, and to their environment has significant implications for both the study of our past as well as understanding of modern human variation. Because mobile lifestyles leave distinct marks on the human body that may not be noticeable in material or social contexts, biological anthropology through bioarchaeology and human biology is well positioned to broaden our understanding of the complexities of nomadic populations and their dynamic relationships to sedentary populations. This has become especially true when seen through the lenses of the innovative and constantly developing applications of isotopic, genetic, morphological, and biocultural analyses. The objective of this session is to unite scholars in biological anthropology studying both ancient and extant nomadic populations to present novel methods and analyses that highlight the utility of biological perspectives in elucidating the lives of mobile people. Our goal is to facilitate the exchange and development of innovative and interdisciplinary approaches that will help bring nomads out of the shadows of their sedentary counterparts and promote understanding of their lives to better serve their needs in the present.

5:00 Discussant: William R. Leonard.

- 1 Socio-cultural influences on genetic variation in nomadic populations of northern Eurasia. T.G. SCHURR.
- 2 Identifying the effects of diverse ecological and biological variability in Bronze-Iron Age Inner Asian steppe populations. M. MACHICEK, J.T. ENG.
- 3 Intra-tooth Isotopic Variation and Implications for Reconstructing Seasonal Diet and Mobility in Ancient Nomadic Populations. S.E. NUGENT.
- 4 Moving across the desert: Investigating the remains of travelers who died traversing the Chilean Atacama. C. TORRES-ROUFF, W.J. PESTLE, G. PIMENTEL, K.J. KNUDSON.

## FRIDAY AFTERNOON SESSIONS

- 5 Mobility patterns among pre-historic shell-mound builder populations from coastal Brazil. M. HUBBE, C. CHEVERKO, M. OKUMURA, W.A. NEVES.
- 6 Limb biomechanics and terrestrial mobility among Pleistocene and Holocene foragers and herders in northern, eastern, and southern Africa. M.E. CAMERON, J.T. STOCK.
- 7 Global Environmental Change: Effects on East African Pastoral Mobility and Biology. K. GALVIN, T. BEETON.

### Session 48

#### Primate Cognition and Ecology

##### Contributed Poster Presentations

*Chair: Colin M. Brand*

Acadia

- 1 Examining Heavy Metal Concentrations in Hair of South African Vervet monkey (*Chlorocebus pygerythrus*) to assess Anthropogenic Impacts. A.E. LEWIS, J.E. LOUDON, J.E. PENDER, J.C. ANDREWS, M.E. HOWELLS, J.P. GROBLER, T.R. TURNER.
- 2 Evidence for Euclidean maps in wild western gorillas (*Gorilla gorilla*). R. SALMI, A. PRESOTTO, D.M. DORAN-SHEEHY.
- 3 Collective-Decision Making and Social Foraging Behavior in White-Faced Capuchins (*Cebus capucinus*). G.H. DAVIS, M.C. CROFOOT.
- 4 Quantifying Countershading in *Eulemur* Using Eigencoats. A.N. SPRIGGS, B.J. BRADLEY, J.M. KAMILAR, A.D. GORDON.
- 5 Evidence for handedness in termite fishing among Gombe chimpanzees. M. FERRY, L.F. MARCHANT, R.C. O'MALLEY.
- 6 The Effects of Age and Sex on Long-term Spatial Memory. M.D. GONZALEZ, M. JANAL, R. WOLK, E. CUNNINGHAM.
- 7 Extractive foraging in wild Tana River Mangabeys, *Cercocebus galeritus*: Implication of Different Physical Properties of Foods. S.M. KIVAI, E.R. VOGEL, J.M. ROTHMAN, C.M. KIVAS, R.A. PALOMBIT.
- 8 Preliminary results of a vocal self-recognition test in northern white-cheeked gibbons (*Nomascus leucogenys*). J. D'AGOSTINO, C. PASETTA, U. REICHARD.

- 9 Bonobos Exhibit Higher Connectivity in the Ventral Anterior Cingulate Cortex Relative to Chimpanzees. H.A. ISSA, N. STAES, J.P. TAGLIALATELA, C.D. STIMPSON, W.D. HOPKINS, C.C. SHERWOOD.
- 10 Sleep tree use by emperor and saddleback tamarins during the dry season: A test of food resource exploitation as a driving factor. M. DE VRIES, M. WATSA, G. ERKENSWICK.
- 11 Crossing Structure Design and Effectiveness for Primate Conservation. I.J. BROCK, L.E. GOTUACO, C.M. BRAND, U.S. STREICHER, L.R. ULIBARRI.
- 12 Long-term spatial memory in *Eulemurs* and effects of learning schedules. R. WOLK.

### Session 49

#### Human Biology and Genetics III

##### Contributed Poster Presentations

*Chair: Theresa E. Gildner*

Acadia

- 1 A Woman's World: Rate of Morphological Dilemmas in Romano-British Childbirth. C. MCGOVERN.
- 2 Patterns of mtDNA Diversity in Central Asia Reveal a Complex Population History. B.M. CHRISTY.
- 3 Whole Mitochondrial Genomes Reveal the Maternal Origin of the Bronze Age Xiabandi Population in Xinjiang, Northwest China. C. NING, Y. CUI.
- 4 Characterizing blood composition in mothers and newborns: Implications for epigenetic studies. C. HSIAO, N.C. RODNEY, J. QUINLAN, C.J. MULLIGAN.
- 5 Human Settlement History of Papua New Guinea Highland Populations. M. LI, K. DEROSA, H. MANN, A. ROOME, S. SCHUTTA, D. CASTELLANOS, S. BENDER, J. ECHARD, K. CASEY, M. SHAMOON-POUR, K. GOWEN, R. SPATHIS, R. GARRUTO, K. LUM.
- 6 One Generation Evolutionary Signal from Human Whole-exome Sequencing Data. T. FERREIRA DE ALMEIDA, D. VICENSOTTO BERNARDO, M.R. SANTOS PASSOS-BUENO.
- 7 New Problems with an Old Idea: Is Human Genetic Variation really Clinally Distributed? J.A. HODGSON.
- 8 Simulating effect of starting configuration on diversity in the context of range expansion. N.J. ANGAL, C.R. TILLQUIST.

## FRIDAY AFTERNOON SESSIONS

- 9 Genome variation across the Bantu to Nilo-Saharan linguistic boundary in Uganda. R.L. RAAUM, D. ISABIRYE.
- 10 MtDNA analysis reveals presence of ancestral lineages between coastal and highland populations in Papua New Guinea. K.L. DEROSA, M. LI, H. MANN, S. SCHUTTA, A. ROOME, W. GUO, D. CASTELLANOS, S. BENDER, J. ECHART, K. CASEY, M. SHAMOON-POUR, H. DULIN, R. SPATHIS, R.M. GARRUTO, J. LUM.
- 11 Genetic variation of southern Africa hunter-gatherers and the impact of admixture with farming and pastoralist populations. M. VICENTE, P. EBBESEN, M. JAKOBSSON, C. SCHLEBUSCH.
- 12 Human races are not the same as dog breeds: Dismantling a powerful popular metaphor as an educational exercise. H. DUNSWORTH, A. BIGHAM, H. NORTON, L. PEARSON, E. QUILLEN.
- 13 Documenting the Changing Reproductive Landscape among Shuar Females from Amazonian Ecuador. F.C. MADIMENOS, M.A. LIEBERT, S.S. URLACHER, T.J. CEPON-ROBINS, T.E. GILDNER, C.J. HARRINGTON, J. SNODGRASS, L.S. SUGIYAMA.
- 14 Associations between testosterone levels and parasite load: Testing life history tradeoffs among indigenous Shuar men from Amazonian Ecuador. T.E. GILDNER, M.A. LIEBERT, T.J. CEPON-ROBINS, R.G. BRIBIESCAS, S.S. URLACHER, J.M. SHROCK, C.J. HARRINGTON, F.C. MADIMENOS, L.S. SUGIYAMA, J. SNODGRASS.
- 15 Relations of hot flash severity, stress and socioeconomic status among Mayan and non-Mayan women in Campeche, Mexico. D.E. BROWN, L.L. SIEVERT, L. HUICOCHEA GOMEZ, D. CAHUICH CAMPOS.
- 16 Does menstrual phase affect the relationships between catecholamines and perceived environmental stress? G.D. JAMES.
- 17 Evidence of Coastal New Guinea Population Geneflow and Implications for the Southern and East Asian Migration Route Hypotheses. S. RAGSDALE, H. MARSH.
- 18 A Study of Structural Variants in Ancient Genomes and their Introgression into Modern Humans. S. RESENDEZ, D. XU, J. BRADLEY, O. GOKCUMEN.
- 19 Modeling the Effects of Multiple Transmission Pathways on the Spread of Enteric Pathogens. J. DIMKA, J. TROSTLE, J.N. EISENBERG.
- 20 Sex-related Connectivity Differences in the LSCN. I.D. GEORGE, K. ALDRIDGE.
- 21 Human sickness behavior not expressed in response to the rabies vaccine. E.C. SHATTUCK, M.P. MUEHLENBEIN.
- 22 Sex Ratio Imbalance affects Marriage and Reproductive Decisions among Pumé Hunter-Gatherers. K.L. KRAMER, R. SCHACHT, R.D. GREAVES, A.V. BELL.
- 23 Early Life Influences on Dual-Hormone Output in Fathers When Playing With Their Children. M.S. SARMA, S. BECHAYDA, L.T. GETTLER.
- 24 Variation in dietary intake and DNA methylation: The possibility of a remnant thrifty epigenotype in populations remaining at risk for seasonal food shortages. M. MOSHER, A.J. WILLIAMS.
- 25 Maternal environment and the composition of breast milk immune proteins in mothers from urban and rural Poland. L.D. KLEIN, E. GOONATILLEKE, A. GALBARCZYK, A. KOTLINSKA, C. LEBRILLA, G. JASIENSKA, K. HINDE.
- 26 Skewed Pattern of X Chromosome Inactivation in Brazilian Women. S.F. OLIVEIRA, D.L. BRANDÃO, A. PIC-TAYLOR, J.F. ARAÚJO.
- 27 Central Asian Turkic and Indo-Iranian Genetic, Linguistic, and Geographic Differentiation. A.G. KITTOE, F. MANNI, É. HEYER, P. MENNECIER.
- 28 Men's status and reproductive success in 33 non-industrial societies: effects of subsistence, marriage system, and reproductive strategy. C.R. VON RUEDEN, A.V. JAEGLI.
- 29 Dating Behaviors and Attitudes among Single Parents in the U.S. C.Y. FRANCO, P.B. GRAY, J.R. GARCIA, A.N. GESSELMAN, H.E. FISHER.
- 30 Pregnancy and the upper volumetric expansion of the barrel-shaped ribcage in *Hylobates* and *Homo*. J. UY, K. O'BRIEN, J. HAWKS.
- 31 Ancient *Yersinia pestis* genomes provide novel insights into the phylogeographic history of Plague. M.A. SPYROU, R.I. TUKHBATOVA, M. FELDMAN, A. HERBIG, K.I. BOS, J. KRAUSE.

### Session 50

#### Paleoanthropology: Early Hominins II

##### Contributed Poster Presentations

Chair: Zachary Cofran

Acadia

- 1 Dental microwear textures of an expanded sample of *Australopithecus africanus* from Sterkfontein Member 4. E.F. ABELLA, F.E. GRINE, M.F. TEAFORD, P.S. UNGAR.
- 2 Paleoenvironmental reconstruction at Kanapoi through use of rodent dental microwear. J.H. BURGEMAN, F. MANTHI, J. PLAVCAN, C.V. WARD, P.S. UNGAR.

## FRIDAY AFTERNOON SESSIONS

- 3 Site-specific cortical bone topographic variation across the whole neck assessed in two hominin proximal femora from Swartkrans Member 1, South Africa: SK 82 and SK 97. M. CAZENAVE, J. BRAGA, F. DE BEER, J.W. HOFFMAN, R. MACCHIARELLI, A. OETTLÉ, J.F. THACKERAY.
- 4 Modularity and the evolution of the human canine. Z. COFRAN.
- 5 Bipedalism evolved from knuckle-walking: Evidence from 3D geometric morphometric analyses of cervical and upper thoracic vertebral shape of *Homo sapiens*, *Pan troglodytes*, and *Pongo pygmaeus*. M. COLLARD, K.A. PLOMP, K. DOBNEY, U.S. VIDARSDOTTIR, D.A. WESTON.
- 6 Using 4th order polynomial curve fitting to assess curvature and allometry of the hallucal facet in extant hominoids and fossil hominins. M.M. DUDAS, W.E. HARCOURT-SMITH.
- 7 An assessment of variation and its causes in the face of *Paranthropus*. N.M. HLAZO, T.D. RITZMAN, R.D. ACKERMANN.
- 8 A Comparison of Upper and Lower Molar Trait Associations in Modern Humans, *Australopithecus*, and *Paranthropus*. E.A. KOZITZKY, S.E. BAILEY.
- 9 DNH 32: A distal humerus of *Paranthropus robustus* from Drimolen, South Africa. M.R. LAGUE, C.G. MENTER.
- 10 Subregion-scale heterogeneity in bovid abundance in the Koobi Fora Formation (Pleistocene, Northern Kenya). C. LLERA, L. BENITEZ, M. BIERNAT, D.R. BRAUN, A.S. HAMMOND, D.B. PATTERSON, W. BARR.
- 11 Re-examining the Peroneal Trochlea of the StW 352 Calcaneus. E.J. MCNUTT, A.G. CLAXTON, K.J. CARLSON.
- 12 Photogrammetric Imaging: A Fresh Look at the Laetoli Hominin Footprints in Relation to Recent Discoveries. A.J. PELISSERO, C.M. MUSIBA, F. MASAO, A. MABULLA, C. MAGORI, E. MARO, A. GIDNA, H.T. BUNN, A. GURTOV, A. SARATHI, J. LI, G. OLE MOITA, M. KAISOE, J. WASHA, J. TEMBA, S. KILLINDO, J. PARESSO, A. LOWASSA, J. MWANKUNDA.
- 13 Dental microwear textures of *Paranthropus robustus* from Kromdraai, Drimolen, and an enlarged sample from Swartkrans. A.S. PETERSON, F.E. GRINE, M.F. TEAFORD, P.S. UNGAR.
- 14 Bipedalism evolved from knuckle-walking: Evidence from 3D geometric morphometric analyses of thoracic and lumbar vertebral shape of *Homo sapiens*, *Pan troglodytes*, and *Pongo pygmaeus*. K.A. PLOMP, U. STRAND VIDARSDOTTIR, D. WESTON, K. DOBNEY, M. COLLARD.
- 15 Plio-Pleistocene paleoenvironments of the Shungura Formation based on bovid dental adaptation and abundance analysis. W.H. REDA, Z. ALEMSEGED.
- 16 Trace element evidence for trophic level in extant mammals from Laikipia, Kenya: implications for eastern African fossil hominin diet reconstructions. C. RYDER, R. QUINN, J. LEWIS, B. POBINER, O. MWEBI.
- 17 Navigating peaks of speciation and extinction: Did prime movers or random effects lead to the composition of the South African fossil record? D.C. PEART, J. MCKEE.
- 18 Taphonomic characterization of the honey badger, an actualistic first. B.F. COHEN, J.M. KIBII.
- 19 A technological study of the lithic artefacts from the Earlier Stone Age site of Maropeng in the Cradle of Humankind, South Africa. R. MOLL, K. KUMAN, D. STRATFORD.
- 20 "Rogue" taxa and hominin phylogeny. M. DEMBO, A. MOOERS, M. COLLARD.
- 21 Large mammal community structure and habitat variability in eastern and southern African *Paranthropus*. K.D. O'NEILL, A.L. RECTOR, C. STEININGER.
- 22 Arm Swing and the Evolution of Shorter Arms in *Homo*. A.K. YEGIAN, S. GILLINOV, Y. TUCKER, D.E. LIEBERMAN.
- 23 New Field Research at Galili, Afar State, Ethiopia. S.W. SIMPSON, J. QUADE, H. SAID.

### Session 51

#### Human Skeletal Biology: Morphology, Variation, and Environment

##### Contributed Poster Presentations

Chair: Meghan Shirley

Acadia

- 1 Shape differences in the proximal femur of a cadaver sample based on different classifiers of obesity. R.A. JOHNSTON, L.W. COWGILL, T. PASKOFF.
- 2 Estimation of individual body mass from the femur: insights from a CT-based analysis of body composition. A. LACOSTE JEANSON, J. DUPEJ, J. BRŮŽEK.

## FRIDAY AFTERNOON SESSIONS

- 3 Osteometric Reconstruction of Body Mass in the Lambayeque Valley Complex, Peru: Pre-Hispanic Variability and the Impact of Spanish Conquest. S.J. BALL, H.D. KLAUS.
- 4 The effect of activity on the reliability of body mass estimated from long bone cross-sectional area. V. SLADEK.
- 5 A Test of the Mastication Hypothesis on Mandibular Morphology using Medieval and Modern Non-adult Individuals. E.E. HAMMERL, M.K. MOORE, E.A. DIGANGI, H.M. JUSTUS.
- 6 From form to function: insights into tooth function through the study of variation in tooth root size and shape. C.L. FERNEE, K.R. BROWN, A. DICKINSON, C. WOODS, S.R. ZAKRZEWSKI.
- 7 Raccoons, humans and Allen's rule in eastern North America. T. STEEGMANN, R. STEEGMANN.
- 8 Climatic adaptation in Japanese macaques (*Macaca fuscata*) as a model for calibrating human intraspecific variation. L.T. BUCK, I. DE GROOTE, Y. HAMADA, J.T. STOCK.
- 9 Why did *H. erectus* disperse? Tracking variables between fleshed and skeletal individuals to find patterns of plasticity. S.C. ANTÓN, H.G. TABOADA, E.R. MIDDLETON, C.W. RAINWATER, T.R. TURNER, J.E. TURNQUIST, K.J. WEINSTEIN, S.A. WILLIAMS.
- 10 Integration and modularity within the human nasal region. N.E. HOLTON, A. PICHE, T.R. YOKLEY.
- 11 An investigation of the relationship between maxillary sinus volume and midfacial growth using a pig model. C.L. NICHOLAS, N.E. HOLTON, B. DOOLITTLE, T. SOUTHARD.
- 12 Statistical shape analysis using statistical shape models - comparing surface to outline data in the human zygomatic structure. S. SCHLAGER, A. RÜDELL.
- 13 Investigating Pterion from Three Perspectives: Phylogeny, Biomechanics and Size. N.J. GAMET, J.C. STEVENSON.
- 14 The Influence of EGCG on Cranial Vault Morphology. J. STARBUCK, E. HARRINGTON, A. GHONEMIA, K. KULA, R. ROPER.
- 15 Generalised Procrustes Analysis on an ontogenetic series clarifies the two-bandage cranial modification technique in Migration Period Hungary. P.R. MAYALL, V. PILBROW.
- 16 Exploring artificial cranial deformation in a 5th century Germanic population from Croatia using multiple lines of inquiry. M. NOVAK, K.A. SIRAK, D.M. FERNANDES, J. BURMAZ, M. ČAVKA, R. HOWCROFT, R. PINHASI.
- 17 Cranial Vault Modification as a Possible Ethnic Marker in the Middle Cumberland Region. G.J. WEHRMAN.
- 18 Geometric Morphometric and Craniometric Analysis of the MidFace in Colombian Population. Allometry and Sexual Dimorphism. S.O. CHIÑAS, M.E. PEÑA, C. SANABRIA, L. MÁRQUEZ.
- 19 A Preliminary Analysis on the Cranial Variation within Prehistoric Mexico. S.R. RENNIE, M. CLEGG, S. GONZALEZ, J.C. LÓPEZ.
- 20 The Use of Geometric Morphometrics to Identify Distinct Mortuary Components at Koster Mounds. L. SACKS.
- 21 Explaining distinct crania from Colonial Delaware using craniometric and genetic analyses. K.A. HAUTHER, A.H. MCKEOWN, M. SNOW, M.K. SPRADLEY.
- 22 Exploration of craniometrics variation along the Nile River. C.R. BENNETT, A.H. ROSS.
- 23 Pelvic morphology and stature in South Asian women. M.K. SHIRLEY, O.J. ARTHURS, J.C. WELLS.
- 24 Osteon circularity variation with femur size and anatomical region in archaeological humans. P. FUENTE GARCÍA, J.J. MISZKIEWICZ, C. DETER, P. MAHONEY.
- 25 Bilateral Asymmetry in Cross-Sectional Properties Indicates Periarticular Plasticity in the Distal Humerus of Modern Humans. K.G. ZELAZNY, C.B. RUFF.
- 26 Are marital system, climate and geographic origin good predictors of human craniofacial size and shape variation? K. BALOLIA, C. SOLIGO.
- 27 Does the shape of the talus predict first metatarsal abduction? S.G. LAUTZENHEISER, A.D. SYLVESTER, P.A. KRAMER.
- 28 Evaluation of the covariation in markers of robusticity in the locomotor skeleton. T.E. DUNN.
- 29 Ontogenetic trajectories of talo-crural joint shape among the two species of *Pan*, *Pan troglodytes* and *Pan paniscus*: Life history and behavioral correlates. K. TURLEY, E.A. SIMONS, S.R. FROST, F.J. WHITE.
- 30 Comparison of fluctuating asymmetry level between normal and pathological specimens from modern Thai skeletal group. H. JUNG, E. WOO, N. VON CRAMON-TAUBADEL.
- 31 Sacral variability in tailless species: *Homo sapiens* and *Ochotona princeps*. R.G. TAGUE.
- 32 Similarities in Pelvic Dimorphism Across Populations. H. DELPRETE.
- 33 Divided Zygomata in Neolithic and Dynastic Northern Chinese Populations. Q. ZHANG, P.C. DECHOW, Q. ZHANG, Q. WANG.

## FRIDAY AFTERNOON SESSIONS

- 34 A 3D geometric morphometric study of the ilium during growth and the influence of habitual activity in the Later Stone Age foragers of southern Africa. H. KURKI, L. HARRINGTON.
- 35 Developmental limb element asymmetry across three Native North American populations. E.B. WAXENBAUM, K.A. SIRAK.
- 36 An analysis of upper and lower limb cross-sectional properties in the Lake Nitchie skeleton from southwestern New South Wales, Australia. E.C. HILL, O.M. PEARSON, A.C. DURBAND.
- 37 Finding the Volume of the Femoral Intercondylar Fossa from a 3D Scanning Image Using CAD Modeling Software. B.E. HERNDON, S.K. BECKER.
- 38 The effect of temperature and population history on the shape of the distal and proximal epiphyses of the tibia. P. IBÁÑEZ-GIMENO, T.G. DAVIES, J.T. STOCK.
- 39 Regional Variation and Sexual Dimorphism in the Ontogeny of Humeral Asymmetry among Prehistoric Hunter-Gatherers. B. OSIPOV, L. HARRINGTON, L. COWGILL, D. TEMPLE, V.I. BAZALIISKII, A.W. WEBER.
- 40 Cortical Bone Structural Variation in Modern Human Metatarsals. T. JASHASHVILI, M.R. DOWDESWELL, L.A. SCHEPARTZ, P. CHABIKULI, B. ZIPFEL, K.J. CARLSON.
- 41 Patterns of Handedness Among Human Populations from the Late Pleistocene to the Holocene. Y. SIEW, E. NIKITA, A.A. MACINTOSH, M.A. GASPERETTI, E. POMEROY, J.T. STOCK.
- 42 Juvenile skeletal sexual dimorphism under poor environmental conditions. S. REEDY.
- 43 Differences between the endosteal surface of human and non-human long bones: a potential feature to assist with identification. S.L. CROKER.
- 44 A Proposed Method for Determining Sex in Skeletal Remains Using the Position of the Sacral Auricular Surface. C.T. SKOOG, C. RANDO, S. HILLSON.

# SATURDAY, MORNING SESSIONS

## Session 52

### Humans as Holobionts: The Microbiome as a Biological System in Human Evolution

#### Invited Podium Symposium

Organizers/Chairs: *Stephanie Schnorr, Meagan Rubel*  
Bissonet

Tiny yet ubiquitous, microbiota play a major role in biological diversification throughout evolution. Symbiosis is not a new concept, having been popularized nearly half a century ago, yet the inclusion of prokaryotes, archaea, and viruses (microbiota) within this conceptual framework has only recently crystallized into the study of the human microbiome. Current research links the microbiome with myriad host physiological functions such as immunity, metabolism, growth, development, reproduction, and behavior. The exact role of the microbiome as a primary epithelial interface between host and environment and the extent of its physiological relevance remains an open area of investigation. Human evolutionary research must therefore consider the communities and activities of associated microbiota to fully understand the selective factors that shaped the human species. Host-microbe associations have likely enabled many key evolutionary transitions over time, as microbial functions can confer adaptive faculties directly to hosts, and hosts mediate microbial colonization and survival through a multitude of physiological and biochemical pathways. This shared selective and adaptive platform challenges notions of a macroscopic singular "self," rather, humans can be considered as "holobionts," or the sum of their host and microbial interdependent parts. The advent of massively parallelized sequencing, meta-omics functional assays, and increasingly sophisticated computational models have facilitated the interrogation of human microbiota at an unprecedented level of detail, revealing microbial functions, mechanisms of molecular information exchange, and genetic variability. This symposium brings together expertise from human evolutionary ecology, immunology, microbiology, and genetics to motivate open discourse about ways in which microbiome research can be effectively used to answer core anthropological questions about the selective factors that shaped human evolution and how this knowledge can be used to inform on contemporary human health issues.

- 8:00 Introduction: Stephanie Schnorr.
- 8:15 The Microbial Organ is Unlike any Other – Evidence for Conflict in Human-Microbiome Co-Evolution. J. ALCOCK, R. KRAJMALNIK-BROWN, J. MALDONADO, A. AKTIPIS, C. HAN.
- 8:30 Meta-OMIC Reconstruction of Host-microbe Interactions in the Primate Gut: Impactions for Human Origins. A. GOMEZ, K. PETRZELKOVA.

- 8:45 Creating context: Using non-human primates to understand the relationship between gut microbes and human diet, physiology, and health. K.R. AMATO, C.A. SCHMITT.
- 9:00 The role of host genetics in determining human gut microbiome composition. E.R. DAVENPORT.
- 9:15 Cospeciation of Gut Microbiota with Hominids. A.H. MOELLER, B.H. HAHN, A.E. PUSEY, E.V. LONSDORF, M.N. MULLER, A.V. GEORGIEV, H. OCHMAN.
- 9:30 Beyond the exclusive presence of *Treponema* and *Bifidobacterium* in the gut microbiota of hunter-gatherers and Western populations: new insights in microbes-host co-evolution. S. RAMPELLI, S. TURRONI, M. CANDELA.
- 9:45 Food and its Form: Cooking Shapes the Gut Microbiome. R.N. CARMODY, P.J. TURNBAUGH.
- 10:00 Break.
- 10:30 Patterns of Variation in the Oral and Gut Microbiomes of Traditional Populations. K. SANKARANARAYANAN, R. TITO, A. OBREGON-TITO, L. MARIN-REYES, C. WARINNER, C. LEWIS JR.
- 10:45 The Global Diversity of the Human Oral Microbiome. A. HÜBNER, M. STONEKING.
- 11:00 The Evolution of Host-microbiome Interactions in Humans. R. BLEKHMANN.
- 11:15 Three Years of Sampling the Gut Microbiota of Free-ranging Capuchin Monkeys (*Cebus capucinus imitator*) in a Tropical Dry Forest. J.D. ORKIN, S.E. WEBB, A.D. MELIN.
- 11:30 Ecology of the Human Gut Microbiome: An Evolutionary Perspective and its Implications for Health. J. WALTER.
- 11:45 Insights from Neandertals and beyond: Evolution of the hominin microbiome on a global scale. L.S. WEYRICH, K. DOBNEY, A. COOPER.
- 12:00 Discussant: Meagan Rubel.

## Session 53

### Primate Reproduction, Parentage, and Life History

#### Contributed Podium Presentations

Chair: *Brian M. Wood*

Balcony I/J

- 8:00 Infant handling in mountain gorillas: establishing its frequency, function and (ir)relevance for life history evolution. C.C. GRUETER, J. HALE, R. JIN, D.S. JUDGE, T.S. STOINSKI.

## SATURDAY MORNING SESSIONS

- 8:15 **Maternal Effects on the Development of Sex Differences in Sociality among Wild Chimpanzees (*Pan troglodytes schweinfurthii*).** Z. MACHANDA, M. EMERY THOMPSON, E. OTALI, M.N. MULLER, R.W. WRANGHAM.
- 8:30 **Male-infant Relationships in Wild Woolly Monkeys (*Lagothrix lagotricha poeppigii*).** L.A. ABONDANO, K.M. ELLIS, A. DI FIORE.
- 8:45 **Female Olive Baboons (*Papio anubis*) Signal Sexual Interest in Socially Stable Males.** J.T. WALZ, D.M. KITCHEN.
- 9:00 **Evidence of higher maternal investment for sons in wild chimpanzees at Ngogo, Kibale National Park, Uganda.** I. BADESCU, A.M. KATZENBERG, D.P. WATTS, D.W. SELLEN.
- 9:15 **Attachment to older siblings can buffer the negative consequences of decreased maternal investment in wild infant olive baboons (*P. anubis*) in Laikipia, Kenya.** C.A. MOST, S.C. STRUM.
- 9:30 **Insulin it to Win It: Patterns, Causes, and Consequences of Insulin Production during the Marmoset Monkey Pregnancy.** J. RUTHERFORD, L. RIESCHE, T. ZIEGLER, C. ROSS, A. SILLS, D. LAYNE COLON, V. DEMARTELLY, S. TARDIF.
- 9:45 **Triangulating weaning in wild geladas (*Theropithecus gelada*) using observational, isotopic, and gut microbial evidence.** A. LU, L.J. REITSEMA, J.C. BEEHNER, T.J. BERGMAN, N. SNYDER-MACKLER.
- 10:00 **Break.**
- 10:30 **Characterizing Non-Maternal Infant Care in a Communally Breeding Primate, *Varecia variegata*.** A.L. BADEN.
- 10:45 **Promiscuity or partner preference? Male-female interactions across reproductive states reflect female strategies for avoiding aggression.** E.E. BOEHM, A.R. ROGERS, S. FOERSTER, E.E. WROBLEWSKI, A.E. PUSEY.
- 11:00 **Differences in Endocrine Fluctuations between Geriatric *Pan troglodytes* and *Homo Sapiens*.** K.H. MACDOWELL, C.T. CLOUTIER BARBOUR, D.C. BROADFIELD.
- 11:15 **Rank Differences in Male Bonobo (*Pan paniscus*) Reproductive Strategies.** C.M. BRAND, A.J. HICKMOTT, K.J. BOOSE, F.J. WHITE.
- 11:30 **Longitudinal changes in diet and reproduction among wild chimpanzees at Kanyawara, Kibale National Park.** M. EMERY THOMPSON, Z.P. MACHANDA, S. PHILLIPS-GARCIA, E. OTALI, M.N. MULLER, R.W. WRANGHAM.
- 11:45 **Menopause is Common among Wild Female Chimpanzees in the Ngogo Community.** B.M. WOOD, K.E. LANGERGRABER, J.C. MITANI, D.P. WATTS.
- 12:00 **Countering infanticide: chimpanzee mothers are sensitive to the relative risks posed by males on differing rank trajectories.** N.E. NEWTON-FISHER, A. LOWE.

### Session 54

#### Functional Anatomy of the Pelvis, Limbs, and Jaws

##### Contributed Podium Presentations

Chair: Marcia S. Ponce de León

Studio 1/2/3

- 8:00 **Linking manipulative abilities to hand morphology in bonobos.** E.E. VEREECKE, M. VANHOOF.
- 8:15 **Obstetric and Non-obstetric Determinants of Pelvic Sexual Dimorphism in Hylobatids.** M.S. PONCE DE LEÓN, M. SCHERRER, C.P. ZOLLIKOFER.
- 8:30 **The Effect of Obstetric Demand on the Magnitude of Sexual Dimorphism in the Birth Canals of Anthropoid Primates.** E.A. MOFFETT.
- 8:45 **Functional adaptations of primate forearm and leg muscle fiber architecture.** A. HARTSTONE-ROSE, C.L. LEISCHNER, F. PASTOR, D. MARCHI.
- 9:00 **Highly Protracted Hindlimbs and a Forward Foot Placement Increase Stability when Walking on Arboreal Substrates.** A. ZEININGER, M.C. GRANATOSKY, D. SCHMITT.
- 9:15 **Modifying Descent Behaviors in Response to Support Steepness in Primates.** B.A. PERCHALSKI.
- 9:30 **Patellar response to knee flexion in the Miocene primates *Epipliopithecus vindobonensis* and *Pierolapithecus catalaunicus*.** M. PINA, D. DEMIGUEL, F. PUIGVERT, J. MARCÉ-NOGUÉ, S. MOYÀ-SOLÀ.
- 9:45 **Three-dimensional Subastragalar Rotation in *Macaca* using XROMM.** S. KUO, N.J. GIDMARK, C.V. WARD.
- 10:00 **Break.**
- 10:30 **Trabecular bone structural variation in the hominin femoral head.** T.M. RYAN, K.J. CARLSON, L.J. DOERSHUK, A.D. GORDON, T. JASHASHVILI, C.N. SHAW, J.T. STOCK.

## SATURDAY MORNING SESSIONS

- 10:45 Variation in the trabecular bone structure of the proximal humerus in four human populations. L.J. DOERSHUK, J.P. SAERS, J.T. STOCK, C.N. SHAW, K.J. CARLSON, T. JASHASHVILI, T.M. RYAN.
- 11:00 Feeding and Locomotor Systems Differ in Joint Excursions. C.F. ROSS, M.C. GRANATOSKY, A.B. TAYLOR, J. IRIARTE-DIAZ, E. MCELROY.
- 11:15 Cross-sectional geometry of the mandibular corpus and food mechanical properties in extant primates. S. COINER-COLLIER, A.C. PASQUINELLI, M.J. RAVOSA.
- 11:30 Dynamic chewing: A novel approach to analyzing three-dimensional motion sequences. M.F. LAIRD, P. O'HIGGINS.
- 11:45 Hard food for stiffer jaws: A comparative Finite Element Analysis of different primate jaws. J. MARCÉ-NOGUÉ, T.A. PÜSCHEL, T.M. KAISER.
- 12:00 Game of bones: intracranial and hierarchical perspective on dietary plasticity in mammals. E.M. FRANKS, J.E. SCOTT, J.P. SCOLLAN, K.R. MCABEE, M.J. RAVOSA.
- 9:00 Utility of deciduous lower first molar crown outlines in diagnosing *Homo sapiens* and *Homo neanderthalensis*. S.E. BAILEY, S. BENAZZI, J. HUBLIN.
- 9:15 Rodeo Riders Revisited: A second look at Neandertal patterns of trauma. J. BAIN, L.W. COWGILL.
- 9:30 A reinterpretation of the Regourdou 1 burial using 3D photogrammetry and field notes from the original excavators. B.A. MAUREILLE, T. HOLLIDAY, A. ROYER, M. PELLETIER, S. MADELAINE, F. LACRAMPE-CUYAUBÈRE, X. MUTH, C. COUTURE-VESCHAMBRE, E. LE GUEUT, E. DISCAMPS, A. TURQ, J. TEXIER, C. LAHAYE.
- 9:45 What we know (and don't) about human sinus variation and climate. T.C. RAE, L.T. BUCK, T. KOPPE.

### Session 55

#### Later Homo Evolution

##### Contributed Podium Presentations

*Chair: Libby W. Cowgill*

Studio 7/8/9

- 8:00 A Taxonomic Scale-explicit Analysis of Brain Size Evolution in the Hominin Clade. A. DU, A.M. ZIPKIN, K.G. HATALA, E. RENNER, J.L. BAKER, S. BIANCHI, K.H. BERNAL, B.A. WOOD.
- 8:15 How the origin of curiosity may have boosted hominin cultural evolution. C. VAN SCHAİK, S. FORSS, L. DAMERIUS.
- 8:30 Characterizing early Pleistocene paleohabitats in Eastern Europe: Results from four years of research in the Olteț River Valley of Romania. S.C. CURRAN, D.L. FOX, N. GARRETT, A. PETCULESCU, C. ROBINSON, M. ROBU, C.E. TERHUNE.
- 8:45 The Middle Pleistocene Human Cranium from Gruta da Aroeira Acheulian site Aroeira (Almonda Karst System, Torres Novas, Portugal). J. DAURA, M. SANZ, J. ARSUAGA, R. QUAM, D. HOFFMANN, M. ORTEGA, E. SANTOS, S. GÓMEZ, A. RUBIO, L. VILLAESCUSA, P. SOUTO, F. RODRIGUES, J. MAURICIO, A. FERREIRA, P. GODINHO, E. TRINKAUS, J. ZILHÃO.
- 10:00 Break.
- 10:30 The dynamics of fundamental niche parameter fluctuation for late Neandertals and Upper Paleolithic humans in Western and Central Europe. R.C. BIBLE.
- 10:45 Of hybrid mice and hominins: disintegration key to understanding hominin hybrid morphologies. K.A. WARREN, C.J. PERCIVAL, T. RITZMAN, B. HALLGRIMSSON, R.R. ACKERMANN.
- 11:00 The zygomatic root in recent and fossil hominids. G.W. WEBER, V.A. KRENN.
- 11:15 Khoe-San and the origins of modern human cranial diversity. P. GUNZ, S.E. FREIDLIN, J. HUBLIN.
- 11:30 The evolution of modern human endocranial shape. S. NEUBAUER, P. GUNZ, J. HUBLIN.
- 11:45 The evolution of human altriciality and brain plasticity in comparative context. A. GÓMEZ-ROBLES, J.B. SMAERS, C.C. SHERWOOD.

## SATURDAY MORNING SESSIONS

### Session 56

#### **Anthropological Demography, Well-being, and the Osteological Paradox: A Symposium in Honor of James W. Wood**

##### **Invited Poster Symposium**

*Organizers/Chairs: Sharon N. DeWitte, Rebecca Ferrell, Corey Sparks, Bethany Usher*

##### **Balcony K**

James W. Wood's 40+ year career in anthropology has taken him from the highlands of Papua New Guinea to the cliffs of the Orkney Islands, and his research has examined a variety of topics related to the biodemography of mortality and reproduction, population ecology, historical demography, and paleodemography. Regardless of topic, Dr. Wood has consistently emphasized analytical and theoretical rigor and creativity and has encouraged the same in his students and colleagues. He has thus directly and indirectly advanced the field in innovative ways. This poster symposium brings together Dr. Wood's colleagues and former graduate students to present specific research projects and syntheses of work that represent the ways that he has helped shape and answer important questions in biological anthropology and other fields. The breadth of topics included in this session demonstrates the interdisciplinary nature of his work and the widespread influence he has had and will continue to have on the field of biological anthropology.

9:00 Individual poster presentations (Posters #1-8).

10:30 Individual poster presentations (Posters #9-16).

- 1 Developmental effects on ovarian function. G.R. BENTLEY.
- 2 Disentangling Fecundability and Fetal Loss: Implications for Age-specific Fertility. D.J. HOLMAN.
- 3 More than just menopause: Processes of female reproductive aging. K.A. O'CONNOR, R.J. FERRELL, D.J. HOLMAN.
- 4 It ain't necessarily "so": James W. Wood, just so stories and the triumph of the proximate determinants approach in human reproductive ecology. D.P. TRACER.
- 5 Risk sensitive fertility behavior in historic Orkney, Scotland. C.S. SPARKS.

- 6 The household ecology of enteric pathogen transmission, diarrheal exposure risk and impaired childhood growth in rural Bangladesh and Kenya. K.Z. LONG, A.S. FARUQUE, T. AHMED, I. GUNANTI, S. ZAMORA, J.P. NATARO, D. NASRIN, M. LEVINE, K. KOTLOFF.
- 7 Household demography and land-use in a rice-farming village in Laos from 1971 to 2013. S. TOMITA, D.M. PARKER.
- 8 Households, Intensification and Well-being: James Wood and the Anthropology of Landscape. T.M. MURTHA.
- 9 Households at the edge of Europe: A reexamination. J.A. JENNINGS.
- 10 Parallel tracks: Cross-fertilization in studies of mortality and fertility throughout human history. L. SATTENSPIEL.
- 11 Experiments with extensions of the Siler model. T.B. GAGE, J.S. NAPIERALA.
- 12 James W. Wood's contribution to the "Rostock Manifesto". L.W. KONIGSBERG, S.R. FRANKENBERG.
- 13 The Osteological Paradox: Its Silver Jubilee. G.R. MILNER, J.L. BOLDSSEN.
- 14 Hidden Heterogeneity in Mortality – Perhaps not so Hidden. J.L. BOLDSSEN, G.R. MILNER.
- 15 Sex differences in pre- vs. post-Black Death trends in survivorship. S.N. DEWITTE.
- 16 Short Children, Short Lives: Selective Mortality in Preindustrial and Prehistoric Communities. C. VIOLARIS, B.M. USHER.

### Session 57

#### **Skeletal Standards: Documentation Software, Databases, and Online Digitization Resources Available to Researchers**

##### **Invited Poster Symposium**

*Organizers/Chairs: J. Christopher Dudar,  
Felix Engel, Leslie Williams*

##### **Studio 4/5**

Standardization of traditional osteological research data and evolving digitization capture is increasingly in demand by physical anthropology for a variety of reasons, such as international repatriation claims reducing institutional collections, or study of remains excavated in the field and subsequently rendered inaccessible by other legislation/policies. In addition, large-scale research projects require the compilation of coherent and accessible data sets from different sources in the scientific community. Since the publication of "Standards

## SATURDAY MORNING SESSIONS

for Data Collection from Human Skeletal Remains" (Buikstra & Ubelaker 1994), various infrastructures for coding and managing digital resources have been developed. Despite these efforts, a common system for making data available has not yet evolved in Physical Anthropology. In order to have a positive impact on research, digital data and digitization standards must meet a number of requirements. Specific capture protocols must be established to reduce inter-observer error and ensure the accuracy, reliability and therefore the comparability of data and imaging compiled. All digital documentation should be coded according to unified standards, which serve as exchange formats when pooling data from different sources. The resulting datasets must then be archived in a way that data structures will be understood and remain accessible into the future. These requirements might imply a rigid separation of standards and software to make data compatible between different systems and applications. However, software development has often accompanied the formulation of data collection standards and plays a key role in advancing their use. In particular standardized data is advantageous only in the presence of digital infrastructures, connecting otherwise separate research endeavors. This session reviews current approaches to data and digitization standardization and related issues, addressing the following questions: how can data and imaging standardization keep pace with methodological innovation? Who should define standards? What prevents large-scale adoption of digital data infrastructures?

**8:30** Authors of even numbered posters present.

**9:00** Software demonstrations.

**10:30** Authors of odd numbered posters present.

**11:00** Comments by discussant George Milner followed by discussion.

- 1 Osteoware: Standardized Skeletal Documentation Software at the Smithsonian Institution.** C. DUDAR, S. OUSLEY, E. JONES, C.W. WILCZAK, J. HEFNER, M. GWYN, D. MULHERN.
- 2 Standardised osteological recording of archaeological skeletal material using an Oracle platform database: The Wellcome Osteological Research Database (WORD).** J.J. BEKVALAC.
- 3 Digitised Diseases and Data Structure: Challenges and Future Directions.** J. BUCKBERRY, T. SPARROW, A.D. HOLLAND, R.A. STORM, K. MANCHESTER, E.L. BROWN, C. GAFFNEY, A.S. WILSON.
- 4 Combining Multiple Osteological Recording Standards in a Single Database: Applications for International Research.** L.L. WILLIAMS.
- 5 Make research explicit using RDFBones, an extensible digital standard for research data.** F. ENGEL, S. SCHLAGER.

- 6 VIRT.OS: virtual osteological library for research, education and heritage preservation.** H. COQUEUGNIOT, A. COLOMBO, B. DUTAILLY, J. BERNARD, P. DESBARATS, O. DUTOUR.
- 7 The On-line IMPACT Radiological Mummy Database: the quest for standardization in mummy studies.** A.J. NELSON, A.D. WADE.
- 8 OsteoSurvey: An Open-source Data Collection Tool for Studying Commingled Human Remains.** A.E. AUSTIN.

### Session 58

#### **Broadening Forensic Anthropology: Bringing East and Southeast Asia to the Forefront**

##### **Invited Poster Symposium**

*Organizers/Chairs: Matthew C. Go, Sean D. Tallman*

##### **Studio 6**

While forensic anthropology has expanded considerably in its theoretical and methodological scope as a discipline, it is nevertheless limited by an over-reliance on data from North America and Europe. Current methods largely developed from American skeletal collections that were established in the late 19th to early 20th centuries have become standards in forensic anthropology. However, it is unlikely that these methods developed on individuals of African, European and Native American descent can be accurately applied to worldwide populations. This is especially true when considering the wide range of human skeletal variation and the increasingly diverse biocultural demographics that exist in modern metropolises globally. In particular, Asian individuals make up approximately 60% of the global population, and East and Southeast Asia represent two of the largest sources of contemporary diasporic communities (approximately 6% of U.S. and 8% of Canadian populations); however, such groups are significantly underrepresented in forensic anthropological literature. Additionally, mass disasters, human rights violations, and armed conflict further necessitate the need for Asian-specific biological profile methods. The increasing number and availability of skeletal collections throughout Asia enables the development of forensic anthropological methods for these understudied populations, thereby addressing this mismatch between classic standards and the call for more representation from East and Southeast Asia. This symposium aims to highlight the diverse research on modern human skeletal variability in East and Southeast Asia that is ameliorating this problematic research gap. Thematic contributions include: the investigation of understudied collections in East and Southeast Asia; the establishment of novel and vital collections; the development of population-specific methods; and the evaluation and applicability of existing techniques. Taken together, these papers push forward the boundaries of current forensic anthropology theory, method, and practice by creating a more inclusive discipline that

## SATURDAY MORNING SESSIONS

better reflects modern global demographics and better benefits local and global communities.

10:30 Discussant: Hallie R. Buckley.

- 1 Building an osteological reference collection of modern Filipino individuals. M.C. GO, A.B. LEE, R. CROZIER.
- 2 A large modern Southeast Asian skeletal collection from Thailand. N. TECHATAWEEWAN, P. TUAMSUK, Y. TOOMSAN, M. NAMKING, P. AMARTTAYAKONG, S. RATANASUWAN, N. TAYLES.
- 3 Visual Versus Algorithmic Pair-Matching in a Modern Filipino Population. A.B. LEE, J. SANTOS, N. VESAGAS, M.C. GO.
- 4 Cranial and Pelvic Nonmetric Sexual Dimorphism in Modern Japanese and Thai Individuals. S.D. TALLMAN.
- 5 Sex Estimation from the Scapula in a Contemporary Thai Population. S.E. SCOTT, T.R. PECKMANN, S. MEEK, P. MAHAKKANUKRAUH.
- 6 Sex estimation from dental crown and cervical metrics in a contemporary Japanese sample. D. ADAMS, M. PILLOUD, D. MALARCHIK, C. ARCE.
- 7 Understanding population-specific age estimation using documented Asian skeletal samples. J. KIM.
- 8 Validity of Post-Mortem Age Estimation Using the Tooth Cementum Annulations in Northeastern Thai Adults. P. TUAMSUK, P. SUWANATHADA, P. PUNGCHANCHAIKUL, N. KANHARAT, N. TECHATAWEEWAN.
- 9 A numerical scoring system for estimation of age-at-death via visual analysis of the pubic symphysis, modelled after the Brooks & Suchey (1990) phasing method, using a Thai population. A.E. BROWN, P. MAHAKKANUKRAUH.
- 10 Stature Estimation from the Calcaneus and Talus in Japanese Individuals. A. HAYASHI, P.D. EMANOVSKY, T.D. HOLLAND.
- 11 Ancestry estimation in Asian and Asian-derived populations using dental morphology. R.L. GEORGE, M.A. PILLOUD, J. GÓMEZ-VALDÉS.
- 12 Using the Digitized Cranial Angle Method for Ancestry Estimation in American Black, American White, and Japanese Individuals. J. MANABE.
- 13 Craniometric Variation in the Modern Thai Population: Forensic Applications and Population History Implications. L. FREAS, P. MAHAKKANUKRAUH, K. VICHAIKAT, P. TUAMSUK, A. SINTHUBUA.
- 14 Examining Japanese and Hispanic Morphological Similarities Using Geometric Morphometrics. B. DUDZIK.

### Session 59

#### Human Biology and Genetics IV

##### Contributed Poster Presentations

*Chair: Melanie A. Martin*

Acadia

- 1 Genetic structure of populations from six cities in Iraq based on 15 STRs. S.D. ALDEN, M. SABBAH, M.H. CRAWFORD.
- 2 Method Development: Enzyme-linked Immunoassay Techniques to Detect Hair Cortisol Concentrations in Afro-textured Hair. J.A. DOYLE, E. BRINDLE, D. ENQUOBAHRIE, S. GOODREAU.
- 3 Objectively Measured Childhood Physical Activity among Small-scale Populations. S.S. URLACHER, J. SNODGRASS, K.L. KRAMER, M. KONECNA, H. PONTZER, L.S. SUGIYAMA.
- 4 The Effects of Lifestyle Factors and Social Support on Physical Activity Patterns among Older Adults from Uganda: Preliminary Analyses from WHO's SAGE-PA Uganda Sub-study. T.J. CEPON-ROBINS, M. KUTEESA, T.M. BARRETT, J. MUGISHA, E. HALLETT, J. SCHROCK, L. GEDDES, P. MBABAZI, P. KOWAL, J. SEELEY, J. SNODGRASS.
- 5 "Skeletal maturation" vs. "critical fat threshold" in relation to pubertal development in Qom girls. M.A. MARTIN, C. VALEGGIA.
- 6 Objectively measured physical activity in a hunting and gathering population. D.A. RAICHLIN, H. PONTZER, J.A. HARRIS, T.W. ZDERIC, M.T. HAMILTON, B.M. WOOD.
- 7 Exploring the Use of Wrist-based Fitness Monitors in Network Creation. T. JASKOWIEC, M.V. FLINN.
- 8 Fosterage on Adult Strength and Body Fat in Himba Women. S. PRALL, B. SCENZA.
- 9 Reduced Immune Investment with Energy Stress: Evidence from a Mouse Model. A.L. SCHNEIDER, N.S. BURGHARDT, H. PONTZER.
- 10 Optimizing Long-Run Energy Harvesting Strategies in Central Asian Nomadic Pastoralists. A.Z. REYNOLDS, P.L. HOOPER.
- 11 Seasonal Fluctuation in Body Fat Sexual Dimorphism among Pumé Hunter-Gatherers. A. ACHENBACH, R.D. GREAVES, K.L. KRAMER.

## SATURDAY MORNING SESSIONS

- 12 Overweight and obesity prevalence and tracking after 2 years follow up study in children and adolescents from Havana, Cuba. V. VAZQUEZ, J. GÁLVEZ, M. DÍAZ, D. NIEBLA.
- 13 Water Soluble Nutrient Intake and Leptin Phenotypes in the Kansas Mennonite. C.E. BARRETT, M. CRAWFORD, M. MOSHER.
- 14 Differential Impacts of Drought on Social and Ecological Adaptations of the Himba Across Local Environments of Kaokoveld. M. ANDERSON, A. HAZEL.
- 15 Stable isotope analysis of hair from three peoples in modern Ethiopia shows clear differences among isotopic signatures related to subsistence regimes. C.G. COOPER, K. LUPO, A. ZENA, M.P. RICHARDS.
- 16 Market integration and lifestyle in Vanutau, and their effects on health. E.D. MASSENGILL, S.M. MATTISON.
- 17 Modern human hair, nail and breath isotopic signals and their relevance to diet assessment in the past. M. CORREIA, R. FOLEY, T. O'CONNELL, F. RAMÍREZ-ROZZI, M. MIRAZÓN LAHR.
- 18 Osteoarthritis as an evolutionary mismatch disease. I.J. WALLACE, S. WORTHINGTON, D.T. FELSON, R.D. JURMAIN, K.T. WREN, H. MAIJANEN, R.J. WOODS, D.E. LIEBERMAN.
- 19 Objectively Measured Physical Activity among the Pokot Agro-Pastoralists of Kenya. M. SAYRE, D.A. RAICHLN, E.N. BUNKLEY, D.A. ODERA, C.A. REEVES, I.L. PIKE.
- 20 The effects of high speed and weighted walking on head pitch and knee forces. J.T. WEBBER, D.A. RAICHLN.
- 21 Inferior Nasal Turbinate Morphology in Arctic and sub-Saharan African Humans: Implications for Understanding Climatic Adaptation in the Nasal Complex. T.N. MARKS, L.N. BUTARIC, S.D. MADDUX, R.G. FRANCISCUS.
- 22 Why are Men's faces More Easily Recognized as Male? Evolutionary Conditioning of Perceptual Biases. T. GONZALEZ-ZARZAR, J. FERNANDEZ, M. BEASLEY, A. ZAIDI, P. CLAES, M.D. SHRIVER, J.K. WAGNER.
- 23 Differences between Human and Chimpanzee Costo-vertebral Joint Anatomy. W.É. CALLISON, D.E. LIEBERMAN.
- 24 Cranial and Mandibular Variation Preceding the Emergence of Agriculture in Eastern Europe and Western Asia. M. GALLAND, A. GROMOV, V. MOISEYEV, S. VASILYEV, E. VESELOVSKAYA, R.M. PINHASI.
- 25 The Neolithic transition at the Western edge of Europe. G.M. GONZALEZ FORTES, T. FRANCESCA, G. SILVIA, H. KIRSTIN, H. MICHAEL, B. GUIDO.
- 26 Harnessing the Power of the Genographic Project Database to Research Migrations in War-Torn Regions: Mitochondrial DNA Diversity in Afghanistan. M.G. VILAR, G. VILSHANSKY, D. MERRIWETHER, M. SHAMOON POUR.
- 27 The Center on American Indian and Alaskan Native Genomics Research: Engaging Ethical, Legal, and Social Issues. J. LUND, S. KETCHUM, P. SPICER, A. COBB-GREETHAM, V. HIRATSUKA, C.M. LEWIS.
- 28 Agent-Based Modeling of Geographic Barriers and Gene Flow in Fuego-Patagonia. V.M. BATTISTA.
- 29 Using historic fixed soft tissues for retrospective genomic analyses: a methodological evaluation. G. FERRARI, H.E. LISCHER, G. AKGÜL, F.J. RÜHLI, A.S. BOUWMAN.
- 30 Measures of Evolvability in Human Body Proportions across Latitude. K.R. SAVELL, B.M. AUERBACH.
- 31 Assessment of Cortical Thickness as a Non-Specific Indicator of Stress in Bone: An Experimental Animal Model. T.M. FRASIER, M.P. ALFONSO-DURRUTY, D. HEADLEY.
- 32 Population genetics analysis of Southeast Asian Ovalocytosis in a cohort of individuals from Island Melanesia. E.A. WERREN, H.L. NORTON, A.W. BIGHAM.

### Session 60

#### Fossil Primates and Environments

##### Contributed Poster Presentations

*Chair: Mary T. Silcox*

Acadia

- 1 New Tools and Methods for Developing a Geospatial Paleoanthropology. R.L. ANEMONE, C.W. EMERSON, B. NACHMAN.
- 2 Evidence for grooming claws in the earliest omomyids. D.M. BOYER, S.A. MAIOLINO, P.A. HOLROYD, P.E. MORSE, J.I. BLOCH.
- 3 New primitive micromomyid plesiadapiform from the Wutu Formation, Shandong Province, China. S.G. CHESTER, K. BEARD, Y. TONG, X. NI, J. WANG.
- 4 New Estimates of Body Mass for "Giant" Subfossil Lemurs using Phylogenetic Regressions and Implications for Relative Brain Size, Life History and Risk of Extinction. K.E. THOMPSON, W. JUNGERS.
- 5 Molar Size and Shape Variation in a Large Sample of *Niptomomys* (Microsyopidae, Primates) from the Paleocene-Eocene Thermal Maximum: One Species or Two? R.S. FELIBERT, P.E. MORSE, S.G. STRAIT, D.M. BOYER, J.I. BLOCH.

## SATURDAY MORNING SESSIONS

- 6 Body size estimation for the Shanghuang petrosal. A.D. KEMP, E. KIRK, K. BEARD.
- 7 Exploring taxonomic and dietary signals in Paromyidae (Plesiadapiformes, Primates) using 3D dental topographic metrics. S. LÓPEZ-TORRES, K.R. SELIG, K.A. PRUFROCK, D. LIN, M.T. SILCOX.
- 8 Internal Nasal Morphology of *Rooneyia viejaensis*: Implications for Crown Primate Olfactory System Anatomy. I.K. LUNDEEN, E. KIRK.
- 9 Phenetic Affinities of *Teilhardina* (Primates, Omomyidae) from the Powder River Basin of Wyoming Reveal the First Known Occurrences of *Teilhardina brandti* Outside the Bighorn Basin. G.S. YAPUNCICH, B.A. WILLIAMS, D.M. BOYER.
- 10 Comparison Between *Parapapio broomi* and *Pp. whitei* from Makapansgat and Sterkfontein, South Africa using Dental Microwear Analysis. L.C. ADAY, F.L. WILLIAMS, W.G. ANDERSON.
- 11 Updated chronology for the Miocene primate succession at Abocador de Can Mata (NE Iberian Peninsula). D.M. ALBA, I. CASANOVAS-VILAR, M. GARCÉS, J.M. ROBLES.
- 12 Niche Separation of Large-Bodied Cercopithecidae at Koobi Fora, Upper Burgi Member. M. ANDERSON, S.R. FROST, E.H. GUTHRIE.
- 13 Now they're Everywhere: New Fossil Primate Remains from Bukwa, Uganda, Demonstrate that Catarrhine Primates are ubiquitous at East African Early Miocene Fossil Sites. S. COTE, L. MACLATCHY.
- 14 Preliminary Study of the Cercopithecidae from Leado Dido'a Locality, Woranso-Mille (central Afar), Ethiopia. H. REDA, S.R. FROST, E. SIMONS, M. ANDERSON, Y. HAILE-SELASSIE.
- 15 Experimental Study of Sheep (*Ovis aries*) Bone Weathering Under UV-B Light. S. HAILESELASSIE.
- 16 Zygomaxillary morphology of *Macaca cf. robusta* (Middle Pleistocene, South Korea) and its phylogenetic and evolutionary implications. T. ITO, Y. LEE, T.D. NISHIMURA, M. TAKAI.
- 17 An assessment of the mandibular ontogeny of *Limnopithecus evansi*. A.C. JAEGER, R.P. KNIGGE, K.P. MCNULTY, E.N. MBUA, F.K. MANTHI, I.O. NENGO.
- 18 Paleoenvironments and mammalian fauna of the early Miocene fossil site at Buluk, Kenya. W.E. LUKENS, D.J. PEPPE, E. LOCKE, E. MILLER, A.L. DEINO, K.O. OGINGA, I. NENGO.
- 19 Proximal Humeral Evidence for Partitioning of Locomotor Substrates by four Catarrhine Species from the Middle Miocene of Maboko Island, Kenya. M.L. MCCROSSIN, B.R. BENEFIT.
- 20 Paleoclimate and Paleoenvironmental Reconstruction of the Early Miocene Fossil Site Koru 16 (Nyanza Province, Western Kenya) and Its Implications for Hominoid Evolution. K. OGINGA, D. PEPPE, W. LUKENS, J. LUTZ.
- 21 New Material of *Turkanapithecus* and *Simiolus* from West Turkana, Kenya. J.B. ROSSIE, S. COTE.
- 22 Ecomorphology of the fossil monkey community of the Hadar and Ledi-Geraru sites, Afar Region, Ethiopia. M. VERGAMINI, A.L. RECTOR, K.L. LEWTON.
- 23 *Oreopithecus bambolii* is still an "enigmatic anthropoid". C. ZANOLLI, D.M. ALBA, M. DEAN, J. FORTUNY, R. MACCHIARELLI, L. ROOK.
- 24 Taxonomic Diversity among Central European Miocene Hominids. D.R. BEGUN, M. BÖHME.
- 25 Endocranial anatomy of Late Paleocene (Clarkforkian NALMA) *Carpolestes simpsoni* (Plesiadapoidea, Primates) from the Bighorn Basin, Wyoming. M.T. SILCOX, R. RUSEN, J.I. BLOCH.
- 26 Three-dimensional analysis of the distal humerus in catarrhines with implications for Miocene locomotor diversity. F. MCGECHIE, S. KUO, C.V. WARD.
- 27 Tracking hylobatid taxonomic diversity from molar morphometrics. A. ORTIZ, C.I. VILLAMIL, C.M. KIMOCK, K. HE, T. HARRISON.
- 28 Forest Composition and Miocene platyrrhine distributions: Why are there No Fossil Monkeys in Florida? J.I. BLOCH, E.D. WOODRUFF, A.F. RINCON, P.E. MORSE, A.R. HARRINGTON, G.S. MORGAN, A.R. WOOD, N.A. JUD.
- 29 Discerning Hominid Taxonomic Variation in the Southern Chinese, Peninsular Southeast Asian, and Sundaic Pleistocene Dental Record. T.R. AVALOS.
- 30 Cranial Variation and Taxonomic Diversity among Late Miocene Hominoids from Yunnan, China. J. KELLEY.
- 31 Intraspecific Variation Among Plio-Pleistocene Primates of South Africa. R. STUDER-HALBACH.

### Session 61

#### **Bioarcheology and Paleopathology: Violence, Activity, Infection, and Congenital Conditions**

##### Contributed Poster Presentations

Chair: Lori A. Tremblay Critcher

Acadia

- 1 Analysis of central american machete cut marks: an application of microprofilometry and micro-computed tomography. S. MITCHELL, A. NOVOTNY, P. LEWIS.

## SATURDAY MORNING SESSIONS

- 2 Bioarchaeological Analysis of Weapon-related Trauma in an Early Medieval Population from Central Europe. L. HOSEK.
- 3 Effect of mycobacterial species on immune cells and its potential impact on inflammatory responses in periosteal lesions. M.E. DUNCANSON, S.N. DEWITTE, F.A. CRESPO.
- 4 Infantile Cortical Hyperostosis or Disseminated Hematogenous Osteomyelitis? The Case of a High Status Child from Huanchaco, Peru. K.E. TSCHINKEL, G. PRIETO, J. VERANO.
- 5 A proposed method for scoring subadult enthesal morphology. J.L. PALMER, A.L. WATERS-RIST, A. LIEVERSE.
- 6 An Analysis of Gender Constructs in an Early Bronze Age Population Through Principal Coordinates Analysis of Scored Enthesal Changes. M. TOUSSAINT, P. WŁODARCZAK.
- 7 Testing the Coimbra Method: Discovering Possible Causes of Fibrocartilaginous Enthesal Change. K.C. JORGENSEN, E.F. KRANIOTI.
- 8 Bulging Biceps: MicroCT Analysis of Enthesal Changes at Byzantine St. Stephen's Monastery, Jerusalem. A.C. PASQUINELLI, K.A. PORTMAN, S.G. SHERIDAN, M.J. RAVOSA.
- 9 Biological Stress Indicators Among Historically Documented Populations (1913-1935): An analysis of Enthesal Changes and Degenerative Joint Disease. A.P. ALIOTO.
- 10 A case of thoracic insufficiency syndrome in Cabeçuda Shellmound, Brasil. S. REIS, A. SALADINO, M. BASTOS, C. RODRIGUES-CARVALHO.
- 11 An Examination of Sex Differences in Pathological Conditions of the Spine in a Historic Population from Milwaukee, Wisconsin. L.A. TREMBLAY CRITCHER.
- 12 Functional associations between Osteoarthritis and Vertebral Osteophytosis in Prehistoric Atacama Oases, Chile. R. LOPEZ BARRALES, V. LLAGOSTERA, W. NEVES, M. HUBBE.
- 13 Comparative analysis of osteoarthritis and implications for division of labor in two prehistoric skeletal populations. A.L. STANCO.
- 14 Palaeopathological Indicators of Mounted Pastoralism during the Mongolian Bronze Age. S.K. KARSTENS, J. LITTLETON, B. FROHLICH, T. AMGALUNTUGS, P. KRISTEN.
- 15 Bioarchaeology of Violence and Disease at Forbush Creek, North Carolina. S. BERGER, D. HUTCHINSON.
- 16 Approaching studies of multiple traumata from the leg up: An examination of the effect of prior injury location on patterns of subsequent injury in 18th and 19th century London. D.A. BOYD, C.F. MILLIGAN.
- 17 Patterns of Trauma and Violence among Nomadic Pastoralists at the Nileke Site (500-221 BCE), Northwestern Xinjiang Province, China. C. LEE, A. BELTRAN-BURGOS, M. ALVAREZ, A. TORRES.
- 18 Evidence for violence along the Silk Road (206 BCE-420 CE), in Xinjiang Province, China. M. JOHNSON, M. SANTOS, A. GARCIA, C. SEPULVEDA, C. LEE.
- 19 Violence in 18th and 19th Century London: Analyzing Trauma Prevalence by Cemetery, Age, and Sex. P. BANKS, D. MILLER.
- 20 Conflict and warfare at the Chandman site (700-400 BCE), in northwestern Mongolia. D. FORNELLI, Y. GONZALEZ, P. ANG, C. CHICKANIS, C. LEE.
- 21 Building America on Broken Bones: Comparative Analysis of Antemortem Fracture Patterns of Three Contemporary American Poorhouse Cemeteries. J.F. BYRNES.
- 22 Trauma Prevalence among Enslaved African Males and Females between the 17th and 19th Centuries in the United States. K. WILLIAMS.
- 23 Evidence of an Iron Age Massacre at the Sandby borg Ringfort. C. ALFSDOTTER, A. KJELLSTRÖM.
- 24 Engaging in Combat: Interpersonal Violence in the Ancient Greek Colony, Himera. C. SAWYER, B. KYLE, N. LONOCE, S. VASSALLO, P.F. FABBRI, L.J. REITSEMA.
- 25 Osteomas on the cranial vault: Survey of presence and frequency Erin N. Hall<sup>1</sup> and David R. Hunt<sup>2</sup>.  
<sup>1</sup>Department of Anthropology, Catholic University,  
<sup>2</sup>Department of Anthropology, Smithsonian Institution.  
E. HALL.
- 26 An Analysis of Human Remains from an Inca Ushnu: Polydactylism, Infection, Blunt Force Trauma, and Sharp Force Trauma at Soledad de Tambo, Huachis, Ancash Peru. A.R. TITELBAUM, J. QUEREVALÚ, N. RIOS, R. CHIRINOS.
- 27 Ace in the Hole: Investigating High Levels of Glenoid Fossa Pathologies in Comparative Samples from the Americas. D.L. NEIDICH, S.A. JOLLY.
- 28 Effects of age, activity, and obesity on osteoarthritis in a modern European-American skeletal sample. A.P. WINBURN.
- 29 Limb Joint Degenerative Joint Disease Prevalence in German Populations from the Little Ice Age (AD 1300-1850). E.J. WADDLE, K. WEINRICH, L.L. WILLIAMS.

## SATURDAY MORNING SESSIONS

- 30 Healed Rib Fractures: A Micro-anatomical Assessment. K.M. HALL, R.R. PAINE.
- 31 Evidence for Cancer and Syphilis in a Prehistoric Native American Population from North Carolina. C.N. WAMSER, C.A. JUAREZ.
- 32 The case of a primary malignant bone tumor in a pre-Columbian skeleton from Cerro Brujo, Bocas del Toro, Panamá. N.E. SMITH-GUZMÁN, J.A. TORETSKY, R.G. COOKE.
- 33 Unidentified, multifocal joint disease from the Slovenian Kranj skeletal series. V. VYROUBAL, M. ŠLAUS, Ž. BEDIĆ, A. PLETESKI, B. ŠTULAR.
- 34 The Effect of Leprotic Infection on the Risk of Death in Medieval Rural Denmark. K.S. KELMELIS, M.H. PRICE, J.W. WOOD.
- 35 Growing Pains: Developmental origins of tuberculosis and periodontal disease in Lisbon's working poor during the turn of the 20th century. J.C. WHITE.
- 36 Pellagra mortality in the historic Mississippi State Asylum: An investigation and comparison of skeletal data and institutional records. M.L. DAVENPORT, M.K. ZUCKERMAN, N.P. HERRMANN, M. MURPHY.
- 37 An Examination of the Osteological Distribution of Leprosy Lesion Types: Results from a Meta-analysis on the Paleopathological Literature on *Mycobacterium Leprae*. M.A. SCHREIER.
- 38 Searching for pathogens in the earliest known colonial epidemic burial in Mexico, Teposcolula Yucundaa. Å.J. VÅGENE, M.G. CAMPANA, N. GARCÍA, D. HUSON, N. TUROSS, A. HERBIG, K.I. BOS, J. KRAUSE.
- 39 Periodontal disease and periosteal lesions in a prehistoric population from Kentucky: searching for evidence of systemic inflammation. K.N. WILHAM, P.J. DIBLASI, S.N. DEWITTE, F.A. CRESPO.
- 40 Spectroscopic Approach to Human Bone/Collagen in Pre-industrial Populations: Preservation vs Chronic Diseases. O. LÓPEZ-COSTAS, M. RIAL TUBÍO, J. KAAL, A. MARTÍNEZ CORTIZAS.
- 41 Differential Diagnosis of a Possible Endocrine Disorder in an Ancient Maya Skeleton from the Chan Site, Belize. A. NOVOTNY, S. MITCHELL.
- 42 Micromorphological study of hypocellular human mastoids. S. FLOHR, A.K. BRESSLER, H. KIERDORF, M. SCHULTZ, U. KIERDORF.
- 43 Single nucleotide polymorphisms in the FGFR3 gene: interpreting cranial, neural, and vascular changes in prehistoric cases of achondroplasia. S.M. LEE, N.K. APODACA, R.S. JABBOUR, G.D. RICHARDS.
- 44 Craniosynostosis and Inheritance: A Bioarchaeological review in the Middle Tennessee River Valley. B.S. THOMPSON.
- 45 Sixth Lumbar Sacralization and Familial Relatedness among Tiwanaku Individuals Buried at M70 in Moquegua, Peru. S.K. BECKER, B.E. HERNDON, G. TORRES MORALES, P.S. GOLDSTEIN.
- 46 Pre-Axial Polydactyly in a Mid-Holocene Human Skeleton from Gobero, Niger. S.E. BURNETT, C.M. STOJANOWSKI.
- 47 The Incidence and Variance of Metopism in Three Medieval British Populations. C.L. BURRELL, S. GONZALEZ, J.D. IRISH.
- 48 Extraction of cortical area thickness profiles from CT-scanned femurs. J. DUPEJ, A. LACOSTE JEANSON, J. BRŮŽEK, J. PELIKÁN.
- 49 The Effect of Mobility Impairment on Femoral Trabecular and Cortical Bone Structure. D.S. GLEIBER, D.J. WESCOTT.
- 50 Eastern States Mental Hospital: Does the Presence of Heavy Metals as Evidenced by pXRF in the Bone and Teeth Indicate use of "Heroic Medicine" ? P.E. KILLORAN.
- 51 Age, Exposure, and Disease: An Osteological Analysis of Three Juvenile Individuals from the Helton Site in the Lower Illinois River Valley. A. ROSSILLO.
- 52 Identification of *Mycobacterium tuberculosis* in dental calculus from the Smithsonian's Huntington Collection. S.E. YOUNG, A.L. WARNER-SMITH.
- 53 Prevalence of Degenerative Joint Disease and Schmorl's nodes in Little Ice Age German populations. K. WEINRICH, E. WADDLE, L.L. WILLIAMS.
- 54 Assessment of the thoracolumbar transition in modern humans. E.O. CHO, T.K. NALLEY, E.R. MIDDLETON, C.V. WARD.

# SATURDAY, AFTERNOON SESSIONS

## Session 62

### Primates and Dietary Ethanol: Evolutionary Outcome, or Modern Accident?

#### Invited Podium Symposium

Organizers/Chairs: *Nathaniel J. Dominy, Robert Dudley Bissonet*

Increasing recognition of the natural occurrence of ethanol within fruits and nectar has prompted speculation concerning the extent of dietary ingestion of this substance by various animals, including primates. Many animals (including modern humans) exhibit sensory and behavioral responses to ethanol-containing foods, but the broader ecological significance as well as evolutionary origins of these responses remain remarkably unstudied. Paleogenetic reconstruction of ethanol-metabolizing enzymes, demonstrable fermentation of sugars within fruits and nectar, and behavioral responses of some primates to ethanol are all consistent with ancestral exposure of hominids, and possibly all primates, to this most widespread of the psychoactive compounds consumed by humans today. Low-level alcohol consumption may thus characterize all nectarivores and frugivores. This symposium will review recent empirical evidence for the natural ingestion of ethanol by primates, the origins of directed fermentations, and assess the possible consequences for routine drinking behavior in modern humans, including excessive consumption.

- 2:30 **Are frugivores and nectarivores boozers too?** R. DUDLEY.
- 2:45 **Toxin Evolution for Organismal Defense: Is Ethanol a Special Case?** R. SULLIVAN.
- 3:00 **Aliphatic esters in primate-consumed fruits: a reliable cue for fruit quality?** O. NEVO, K. VALENTA.
- 3:15 **Spider monkeys and the functional ecology of olfactory sensitivities to alcohol.** L. HERNANDEZ-SALAZAR, M. LASKA.
- 3:30 **The 'Drunken Monkey' Hypothesis and spider monkeys (*Ateles geoffroyi*): Further Evaluation.** C.J. CAMPBELL, V.R. WEAVER, R. DUDLEY.
- 3:45 **Hominids adapted to metabolize ethanol long before human-directed fermentation.** M.A. CARRIGAN.
- 4:00 **Nectar and the genetic basis of ethanol metabolism in Euarchonta.** A.D. MELIN, G. DUYTSCHAEVER, K. WELLS, P. ONG, N.J. DOMINY.
- 4:15 **Some Strepsirrhines Prefer Alcohol.** N.J. DOMINY, S.R. GOCHMAN.

- 4:30 **Wild chimpanzees consume alcohol using tools.** K.J. HOCKINGS, T. MATSUZAWA.
- 4:45 **Origins of yeast domestication, as revealed from wine.** J. LEGRAS.
- 5:00 **Discussant: Erin R. Vogel.**

## Session 63

### Up Goer Five PhysAnth Edition: Communicate Your Science Using English's Ten Hundred Most Common Words

#### Invited Podium Symposium

Organizers/Chairs: *Kim Valenta, Katherine H. Bannar-Martin*  
Studio 7/8/9

A major challenge to scientific researchers is effectively disseminating and communicating their work to diverse audiences. If we are to motivate change, human understanding, or explain the importance of our research to funding bodies and public policy makers, we must find ways to communicate complex concepts and findings to non-specialists. In this session, all speakers have agreed to the rules of the Up Goer Five challenge - to describe their research using only the top 1,000 most common words in the English language. Presentations will be followed by a moderated discussion about the role of language in physical anthropology and science communication.

- 4:45 **Dogs go places they are not from and eat weird animals in their homes: Reasons for fewer weird animals.** K. VALENTA, Z.J. FARRIS, S. ZOHDY.
- 4:50 **How to tell people who are from a place and people who are not from that place by how they are put in the ground after death and from things in their teeth.** M.A. KATZENBERG, A.M. OFFENBECKER.
- 4:55 **Why Eating Flies and other very tiny Animals was Probably Important to No-longer-living, Human-like Animals.** J.J. LESNIK.
- 5:00 **How Much Food do Animals Need to Walk, Run, and Climb? This Much.** H. PONTZER.
- 5:05 **Tiny Old Dead Human-Like Animals Found in Rocks and What They Tell Us about How Life Changes Over a Long Time.** A.L. ATWATER, E.C. KIRK.
- 5:10 **Are jumping tree animals getting smaller over time because humans catch and eat the larger ones?** A.P. SULLIVAN, L.R. GODFREY, R. LAWLER, T. RYAN, G. PERRY.

## SATURDAY AFTERNOON SESSIONS

- 5:15 The relationship between the soft pink things and the hard white things. K.N. RABEY, R. MOSKAL, K.G. HATALA, E. WILLIAMS-HATALA.
- 5:20 Little Green Men, Huge Angry People, and Across the Water Visits: Very Wrong Things People Say about Old Times in the New World. R.W. SMITH, J.A. RAFF.
- 5:25 Which tree animal types live in areas together, and why? In part because of people things. K.H. BANNAR-MARTIN.

### Session 64

#### Human Adaptive Variation/ Integrative Approaches

##### Contributed Podium Presentations

*Chair: Courtney L. Meehan*

Balcony I/J

- 2:30 Understanding human brain evolution through neuropathology: the case for Williams syndrome. K.L. HANSON, C.F. HORTON LEW, U. BELLUGI, K. SEMENDEFERI.
- 2:45 Effects of Agricultural Transitions on the Evolution of Human Sensory Systems. C.C. VEILLEUX, E.C. GARRETT, R.J. BANKOFF, N.J. DOMINY, G.H. PERRY, A.D. MELIN.
- 3:00 Association between maternal stress and telomere length in the eastern Democratic Republic of the Congo. P.H. REJ, N.C. RODNEY, D.A. KERTES, C.J. MULLIGAN.
- 3:15 Deflating the "Good Genes Hypothesis": Asymmetry may not be an honest indicator of genetic quality in humans. J.D. WHITE, A.A. ZAIDI, C.M. BERGEY, T. GONZALEZ-ZARZAR, P. CLAES, M.D. SHRIVER.
- 3:30 Genome-wide cytosine methylation differences between ancient hunter-gatherers and farmers. D. KOPTEKIN, G.M. KILINÇ, A.P. SÜMER, M. DÖNERTAŞ, M. SOMEL.
- 3:45 Altered DNA Methylation of Methylation Complex Genes in Relation to Maternal Stress. C.J. CLUKAY, D.A. HUGHES, N.C. RODNEY, D.A. KERTES, C.J. MULLIGAN.
- 4:00 Genome-wide epigenetic signatures of high-altitude adaptation in Peru. A. CHILDEBAYEVA, D.C. DOLINOY, J.M. GOODRICH, M. RIVERA-CHIRA, F. LEON VALERDE, M. KIYAMU, T. BRUTSAERT, A.W. BIGHAM.
- 4:15 Costs of reproduction assessed via telomere length and epigenetic age measures of biological senescence in young adult women from Cebu, the Philippines. D.T. EISENBERG, M. HAYES, T. MCDADE, C.P. RYAN, A. GEORGIEV, M. JONES, M.S. KOBOR, C.W. KUZAWA.
- 4:30 Patterns of Genetic Coding Variation in a Native American Population Before and After European Colonization. J. LINDO, B. PETZELT, J. MITCHELL, M. DEGIORGIO, R.S. MALHI.
- 4:45 Assessment of DNA Methylation Patterns in Nonhuman Primate Skeletal Tissue. G. HOUSMAN, E. QUILLEN, A.C. STONE.
- 5:00 The Social Worlds of Mothers, Infants, and Microbes: Cooperative Breeding and the Human Milk Microbiome. C.L. MEEHAN, K.A. LACKEY, E.H. HAGEN, J.E. WILLIAMS, M.A. MCGUIRE, M.K. MCGUIRE.
- 5:15 Mother's milk oligosaccharides and infant gut microbiota: seasonality and infant outcomes in rural Gambia. R.M. BERNSTEIN, J.C. DAVIS, Z.T. LEWIS, S. KRISHNAN, S.E. MOORE, A.M. PRENTICE, D.A. MILLS, C.B. LEBRILLA, A.M. ZIVKOIVC.
- 5:30 Associations between biomarkers of immune function and cognitive performance in forager-horticulturalists with high parasite and pathogen loads. B.C. TRUMBLE, J. STIEGLITZ, A.D. BLACKWELL, B. BEHEIM, D.K. CUMMINGS, H. KAPLAN, M. GURVEN.
- 5:45 The Hormonal and Elemental Composition of Dehydrated Human Placenta Capsules. L.K. GRyder, S.M. YOUNG, W.B. DAVID, Y. TENG, D. ZAVA, D.W. KIMBALL, S. GERSTENBERGER, D.C. BENYSHEK.

### Session 65

#### Primate Evolutionary Morphology

##### Contributed Podium Presentations

*Chair: Kimberly Congdon*

Studio 1/2/3

- 2:30 Estimating primate morphological ancestors: Implications for the analysis of hominoid cranial evolution. N. VON CRAMON-TAUBADEL, L. SCHROEDER.
- 2:45 Homoplasmy in papionins: an explanation from genetic sources of variation shared by body size and craniofacial form. J.L. JOGANIC, K.E. WILLMORE, J.T. RICHTSMIEIER, L.A. COX, M.C. MAHANAY, J. ROGERS, J.M. CHEVERUD.

## SATURDAY AFTERNOON SESSIONS

- 3:00 Processes that generate modularity in the mammalian skull: implications for primate skull evolution. N. SINGH, R.H. REEVES, J.T. RICHTSMEIER.
- 3:15 Trait Variation, Convergence, and Ecogeographic Patterns in *Macaca* Crania. S.J. WILLIAMS, B.M. AUERBACH.
- 3:30 The evolution of hominoid cranial diversity: a quantitative genetics approach. L. SCHROEDER, N. VON CRAMON-TAUBADEL.
- 3:45 Running behavior predicts brain size in primates. A.M. DELOUIZE, F.L. COOLIDGE.
- 4:00 Functional Morphology of the Hominoid Ankle Joint: Locomotor Activity and Shape Variation of the Tibial Plafond. M.A. FRELAT, T. JASHASHVILI, K.J. CARLSON.
- 4:15 Trabecular anisotropy in the primate lower ilium reflects locomotor mode. D. SHAPIRO.
- 4:30 Locomotor mode and kinematics of the head, neck, and trunk in *Varecia variegata*. N. GRIDER-POTTER, A. ZEININGER.
- 4:45 Does increased contact with an arboreal substrate result in decreased digital grasping pressures? K.A. CONGDON.
- 5:00 Automatic segmentation of morphological structure into biologically corresponding features: implications for systematics and ecomorphology. E.L. FULWOOD, T. GAO, I. DAUBECHIES, D.M. BOYER.
- 5:15 Which Tooth Best Predicts Diet using Dental Complexity in Fossil Primates? S. PINEDA-MUNOZ, I.A. LAZAGABASTER.
- 5:30 The role of the hypocone in primate diversification: a test of the key-innovation hypothesis. J.E. SCOTT.
- 5:45 Dietary properties, chewing patterns and cyclical loading: It's wicked hard always being tough. M.J. RAVOSA, S. COINER-COLLIER, K.R. MCABEE, A.L. FLING.
- 6:00 Exudate-feeding in Lorisidae: Evolutionary divergence in the toothcomb and lower molar. A.M. BURROWS, A. HARTSTONE-ROSE, L.T. NASH.

### Session 66

#### Division of Fossil Primates, Duke Lemur Center – 40th Anniversary Symposium

##### Invited Poster Symposium

Organizers/Chairs: Gregg F. Gunnell, Erik R. Seiffert, Ellen R. Miller, Prithijit Chatrath

##### Balcony K

In 1977 Elwyn Simons moved from Yale University to become the Director of the Duke Primate Center. At that time he also established the Division of Fossil Primates (DFP) in order to enable and promote the study of primate evolutionary history at Duke University. When Simons arrived in Durham he already had an established field program in the Fayum Depression in Egypt where 30-37 million year old iconic fossils related to anthropoid origins were being found. Subsequently, in 1983 he initiated field work in Madagascar seeking subfossil specimens to document the giant lemurs that had once inhabited the island. In addition, whenever possible Simons augmented the collections at the DFP by trips to Wyoming to collect early Eocene fossil primates from the Willwood Formation. Also, occasional trips to India in search of Miocene monkeys and apes were interspersed along the way. All told, Simons and his trusted colleague Prithijit Chatrath led expeditions that amassed nearly 60,000 specimens over a 40 year history – of these over 35,000 are now housed at the DFP while the rest are stored in Cairo, Haritalyangar and Antananarivo. The DFP collections are unique and represent by far the most complete collection documenting the origination and radiation of early anthropoid primates anywhere in the world. Additionally, the collections from Madagascar are large and wide-ranging rivaled only by the collections at the American Museum of Natural History in New York, the Museum National d'Histoire Naturelle in Paris and those in Madagascar. Over 200 students and colleagues have been involved with field work over the past 40 years. This symposium features some of the students and professionals who have been directly responsible for amassing and studying the DFP collections over the years and highlights the discoveries that have influenced and advanced the sciences of primate paleontology and paleoanthropology.

4:00 Discussants: John G. Fleagle and Laurie Godfrey.

- 1 Brain Proportions in Early Anthropoid Evolution: Evidence from the Fayum Fossil Record. R. LAVINGIA, K.L. ALLEN.
- 2 Documenting Skeletal Anatomy of Early Adapiforms. L.A. GONZALES, C.H. CRAWFORD, J.T. GLADMAN, J.P. ALEXANDER, J.I. BLOCH, G.F. GUNNELL, D.M. BOYER.

## SATURDAY AFTERNOON SESSIONS

- 3 **A multi-isotope investigation of extinct monkey lemurs (*Archaeolemur*) from Antsirondoaha cave, Madagascar.** B.E. CROWLEY.
- 4 **Exploring the mode and tempo of Madagascar's lemuriform radiation.** S. FEDERMAN, G. GUNNEL, R. RIVAS, E. SARGIS, A. YODER, G. PERRY, A. DORNBURG.
- 5 **Evolution of the primate vomeronasal system: fossil evidence from the Fayum.** E.C. GARRETT, L.A. GONZALES, E.C. KIRK, E.R. SEIFFERT.
- 6 **Distal Phalanges and the Origin of Crown-Group Anthropoids.** D. GEBO, M. DAGOSTO, C. BEARD, X. NI.
- 7 **Early anthropoid dental eruption and development.** G.F. GUNNELL, E.R. MILLER, E.R. SEIFFERT, H.M. SALLAM, G.T. SCHWARTZ.
- 8 **The impact of fossil data on inferences of lemur biogeographic history.** J.P. HERRERA.
- 9 **Are there any African Platyrrhines?** R.F. KAY, B.A. WILLIAMS.
- 10 **Evaluating Ecological Change in Western Madagascar: A Paleontological Perspective.** K.M. MULDOON.
- 11 **New fossils and the paleobiology of *Karanisia clarki* from the late Eocene of Egypt.** B.A. PATEL, D.M. BOYER, B.A. PERCHALSKI, T.M. RYAN, E.M. ST. CLAIR, J.M. WINCHESTER, E.R. SEIFFERT.
- 12 **Covariation in life history, body and brain size, and molecular substitution rate across the diverse radiation of extant and extinct (megafaunal) lemurs.** G. PERRY, L. KISTLER, G.T. SCHWARTZ, L.R. GODFREY, L. ORLANDO.
- 13 **An additional caenopithecine adapiform primate from the late Eocene of Egypt.** E.R. SEIFFERT, D.M. BOYER, J.G. FLEAGLE, J.M. PERRY, H.M. SALLAM, G.F. GUNNELL.
- 14 **Exploring an Undersampled Interval in Primate Evolutionary History: Insights from the Late Oligocene Nsungwe Formation of Tanzania.** N.J. STEVENS, E.M. ROBERTS, P.M. OCONNOR.
- 15 **Bayesian Tip-dating of Caviomorph Rodent Phylogenies provides New Age Estimates for South America's oldest Platyrrhines.** D. DE VRIES, E. SEIFFERT.

### Session 67

#### **The Paleobiology of Upper Paleolithic/ Later Stone Age Humans**

##### **Invited Poster Symposium**

*Organizers/Chairs: Erik Trinkaus, Sébastien Villotte*

Studio 4/5

The past few decades of paleoanthropological research has seen a focus on the human paleobiology (and mortuary analysis) of the Upper Paleolithic / Later Stone Age (~40 – ~10 ka). These people have been increasingly viewed in terms of dynamic and culturally complex forager populations in a changing global climate, instead of being studied merely in terms of the establishment of modern versus archaic human biology. These analyses have been concerned with trends through this period in shifting body proportions, reflections of activity levels, growth and development, changing levels and patterns of paleopathology, aspects of dental structure and wear, skeletal reflections of diverse mortuary behaviors, patterns of population diversity and dispersal, and adaptations to diverse environments. The research has been greatly augmented by detailed reassessments of long-known important human skeletal samples, combined with the analyses of newly discovered remains. This symposium brings together an international group of paleoanthropologists addressing these issues with new data, new analyses and new fossils. It is designed to foster discussion on the biology and behavior of these Late Pleistocene early modern humans, the people who reflect both the heyday of highly successful global hunter-gatherers and provided the background for the increased sedentism of the early Holocene.

2:30 **Introduction: Erik Trinkaus and Sébastien Villotte.**

5:00 **Discussant: Brigitte Holt.**

- 1 **Upper Paleolithic and recent human brain variation and evolution.** A. BALZEAU, D. GRIMAUD-HERVÉ, L. ALBESSARD.
- 2 **Dental developmental patterns and tooth internal structure in European Upper Paleolithic humans.** P. BAYLE, M. LE LUYER.
- 3 **Late Pleistocene modern human diversity in Central Africa.** I. CREVECOEUR, A. BROOKS, I. RIBOT, P. SEMAL.
- 4 **Effects of technology on Upper Paleolithic human diet.** S. EL ZAATARI, F.E. GRINE, P.S. UNGAR, J. HUBLIN.
- 5 **Later Stone Age infant remains from the Grotte des Pigeons at Taforalt.** L. HUMPHREY, A. FREYNE, A. BOUZOUGGAR, N. BARTON.

## SATURDAY AFTERNOON SESSIONS

- 6 Evidence for Subsistence Shifts in the Late Upper Paleolithic of Europe: Caries and Antemortem Tooth Loss. S.A. LACY.
- 7 Dental remains of Late Pleistocene European foragers: external and internal characterization. M. LE LUYER.
- 8 Variation among inferred habitual activity in Upper Pleistocene modern humans. O.M. PEARSON, E.C. HILL, V.S. SPARACELLO.
- 9 The Upper Paleolithic human remains from the Troisième caverne of Goyet (Belgium). H. ROUGIER, I. CREVECOEUR, A. GÓMEZ-OLIVENCIA, P. SEMAL.
- 10 Infracranial variability among the Magdalenian people of southwestern France. M. SAMSEL, C.J. KNÜSEL, S. VILLOTTE.
- 11 Paleobiology, Competition and Migration in Late Pleistocene Southeast Asia. A. ZACHWIEJA, L.L. SHACKELFORD.
- 12 Morphological variability of Upper Paleolithic and Mesolithic skulls from Sicily. L. SINEO, M. GALLAND, G. D'AMORE, M. FRIESS, R. PINHASI, R. MICCICHE'.
- 13 Late Upper Paleolithic funerary behavior at Arene Candide Cave (Finale Ligure, Italy). V.S. SPARACELLO, S. ROSSI, P. PETTITT, C.A. ROBERTS, J. RIEL-SALVATORE, V. FORMICOLA.
- 14 Early and Middle Epipalaeolithic human remains from Jordan: implications for understanding late Pleistocene population and foraging complexity in the Levant. J.T. STOCK, E. POMEROY, T. DAVIES, T. RICHTER, L. MAHER.
- 15 Population movements throughout northern Africa during the Pleistocene-Holocene transition. C.M. STOJANOWSKI, R. BOOKMAN, C.L. CARVER.
- 16 Puzzling Pairs from Pavlov: Mortuary Manipulation in the Mid Upper Paleolithic. E. TRINKAUS, P. WOJTAL, J. WILCZYNSKI, S. SAZELOVA, J.A. SVOBODA.
- 17 Gravettian human remains from Gargas (Hautes-Pyrénées, France). Implication for biological diversity and mortuary practices during the Upper Paleolithic. S. VILLOTTE, P. BAYLE, S. NATAHI, C. VERCOUTÈRE, C. FERRIER, C. SAN JUAN-FOUCHER, P. FOUCHER.
- 18 Biological and Cultural Factors influencing Non-masticatory Dental Wear in Early and Late Upper Paleolithic Humans. J.C. WILLMAN, K.L. KRUEGER.

### Session 68

#### Stable Isotope Advances in Studies of Stress and Disease

##### Invited Poster Symposium

Organizers/Chairs: Sammantha N. Holder, Laurie J. Reitsema

##### Studio 6

This session explores recent advances and future prospects in the application of stable isotope data to human paleopathology. Stable isotope analysis of human remains is widely used in anthropology to reconstruct past diet and migration, based on the adage "You are what you eat." In addition to diet, pathological conditions and physiological stress affecting fractionation, uptake, and distribution of isotopes throughout the body also create isotopic variation in tissues. Although this additional source of isotope variation complicates dietary reconstructions, it provides novel opportunities for studying past stress and health in archaeological remains. The last 10 years have seen a surge in research exploring the utility of stable isotope ratios as indicators of malnutrition, stress, and disease. This symposium assembles some of this research into *in vivo* fractionation and distribution of isotopes, and addresses a persistent question: How may stress-induced fractionation and stable isotope variation shed light on questions of past health, when the tissues sampled are relatively inert? Subjects of particular interest include sampling strategies, tissue turnover, theoretical issues of health and disease, and individuals or groups with known histories of ill-health.

#### 2:30 Individual poster presentations and discussion led by Anne Katzenberg.

- 1 Addressing the Inertness of Bones and Teeth in Isotopic Studies of Stress and Disease: A review of Advances and Future Prospects. S. HOLDER, L.J. REITSEMA, C.J. GARLAND, A.K. SMITH, J. LUNSFORD, M. KRAJEWSKA, T. KOZLOWSKI.
- 2 The Effects of Pathology on the Intra-tissue Carbon and Nitrogen Isotopic Variability of Human Bone Collagen. K.C. OLSEN, C.D. WHITE, F.J. LONGSTAFFE, K. VON HEYKING, G. MCGLYNN, G. GRUPE, F.J. RÜHLI.
- 3 Stable Isotope Reconstruction of Maladaptive Breastfeeding and Weaning Practices in a 19th Century Rural Dutch Community: The Effect of Possible Negative Nitrogen Balance on Stable Nitrogen Isotope Values. A.L. WATERS-RIST, M.L. HOOGLAND.

## SATURDAY AFTERNOON SESSIONS

- 4 The Impact of Caloric Restriction on Tissue Isotopic (Nitrogen, Carbon and Oxygen) Values. N.C. TUROSS.
- 5 Early Life Stress at the Mission Santa Catalina de Gualle: Combining Enamel Defects and Incremental Isotope Analysis of Dentin to Explore Nutrition as a Source of Stress. C.J. GARLAND, L.J. REITSEMA.
- 6 Sub-seasonal oxygen isotope variations in human bone reflect changes in drinking water. C.M. MAGGIANO, C. WHITE, R. STERN, F.J. LONGSTAFFE.
- 10 Morphological integration of anatomical, functional, and developmental modules of the postcranium in the Crab-eating Macaque (*Macaca fascicularis*). M.A. CONAWAY, L. SCHROEDER, N. VON GRAMON-TAUBADEL.
- 11 Hominoid scapular morphology suggests a generalized last common ancestor. M.S. SELBY, C. LOVEJOY.
- 12 The Relationship of the Glenoid Fossa and Acromion process as a Predictor of Locomotor Behavior. K.E. BAILEY, N.B. GROW.

### Session 69

#### Functional Anatomy of the Limbs

##### Contributed Poster Presentations

Chair: Aidan A. Ruth

Acadia

- 1 Hindlimb Bone Strength Ratios reveal Decreased Limb Tapering in Humans vs. Other Great Apes. M.N. COSMAN, S. SCHLECHT, K. JEPSEN, L. MACLATCHY, M. DEVLIN.
- 2 When I Grow Up; Limb Development and Adaptation in Old World Primates. J.A. NADELL, S. ELTON, K. KOVAROVIC.
- 3 Pronogrady, not fast speed specifically, acts as a constraint on vertebral formula in mammals. M.R. SHATTUCK, L.A. PETRULLO, A. PETERSON, A.B. LEE, E. KACZMAREK, D.M. GOLDSTEIN, S.A. WILLIAMS.
- 4 Intraspecific Variation during Quadrupedal Locomotion in Mammals. M.C. GRANATOSKY, P. LEMELIN, C.F. ROSS, E. MCELROY, D. SCHMITT.
- 5 Is all Quadrupedalism the Same? Form-function Relationships in Behaviorally Flexible Primates. D. SCHMITT, M.C. GRANATOSKY.
- 6 Bipedal Loading Behaviors do Not Always Induce Cross-sectional Changes in Bone. A.D. FOSTER.
- 7 Quantifying muscular response to habitual activity: Toward understanding muscle-bone interactions for anthropological behavioral reconstructions. C.M. TURCOTTE, K.N. RABEY, D.J. GREEN, S.C. MCFARLIN.
- 8 A foot for all seasons: Grauer gorillas reveal the effects of phylogeny and function on the evolution of gorilla foot morphology. M.W. TOCHERI, R.P. KNIGGE, C.M. ORR, K.P. MCNULTY.
- 9 Morphological correlates of limb differentiation in the cross-sectional geometric properties of anthropoid primate metapodials. S.H. BUI, B.A. PATEL.
- 13 Intraspecific Variation and Functional Morphology in the Humerus of Cercopithecoids. A. GOSSELIN-ILDARI.
- 14 Examining the influence of function and phylogeny on skeletal shape: A case study involving proximal and distal articular surfaces of hominoid third metacarpals. T.R. REIN.
- 15 Quinticeps? Investigating a Possible Fifth Head of the Quadriceps femoris in Non-human Primates. H.W. HEMINGWAY, M.N. MUCHLINSKI.
- 16 The relationship of knee rotation to lateral meniscus shape and attachments in hominoids. A.A. RUTH.
- 17 Gait Asymmetry in Humans and Other Animals: How much is Normal and Why Does it Exist? A.Z. FITZSIMONS, M.C. GRANATOSKY, R.M. QUEEN, P. LEMELIN, A. ZEININGER, H. CHAPMAN, D. SCHMITT.
- 18 Intrinsic manual proportions affect the biomechanics of suspension. K.R. RAMIREZ, H. PONTZER.
- 19 Morphological Correlates of Locomotor Mode in the Volar Pads of Strepsirrhine Primates. A.K. KINGSTON.
- 20 Hand and foot postures during vertical clinging and grasping: implications for digit length in primates. L.E. JOHNSON, D. SCHMITT.
- 21 Calcaneal trabecular structure in terrestrial and arboreal primates and marsupials: implications for the locomotor behaviour of the extinct wombat, *Phascolmys mitchelli*. D.A. SFORZIN, V.C. PILBROW, D.C. ACKLAND.
- 22 Lateralization in the Slow Loris (*Nycticebus* spp.) 'Venom Pose'. S.A. POINDEXTER, K. NEKARIS.
- 23 Geometric morphometric analysis of variation in human hallucal metatarsal periosteal and endosteal shape in rural and urban populations. L.A. WILSON, I. DE GROOTE, L.T. HUMPHREY.
- 24 A geometric morphometric analysis of pollical metacarpal shaft morphology in Gorilla, Pan, and Homo. L.A. BOWLAND, J.E. SCOTT, B.A. PATEL, M.W. TOCHERI, C.M. ORR.

## SATURDAY AFTERNOON SESSIONS

- 25 Exploring morphological shape variation in modern human tali. R. SORRENTINO, C. MINGHETTI, W. PARR, K. TURLEY, S. WROE, C. SHAW, J. SAERS, A. SU, L. FIORENZA, F. FELETTI, S. FROST, K.J. CARLSON, M.G. BELCASTRO, T. RYAN, S. BENAZZI.
- 26 Walking in their shoes: A multidisciplinary approach to understanding tarsal coalition in Medieval Exeter. M.E. ALBEE.
- 27 Kinematic Effects of Body Size Differences during Walking. M.C. FOX, K.K. WHITCOME, J.D. POLK.
- 28 Ontogenetic Changes and Adult Variation in Human Metatarsal Torsion. A.N. HEARD-BOOTH, A.D. KEMP.
- 29 Incorporating Spatial Analysis into a Whole-epiphysis Approach to Studying Trabecular Bone Structure in the Distal Femur of *Homo*, *Pan*, *Pongo*, and *Papio*. S.M. SUKHDEO, T.M. RYAN.
- 7 Age and Sex-related Changes in Cross-Sectional Geometry in a 17th-19th Century Rural Dutch Population. C. CHILCOTE, A.L. WATERS-RIST, M.L. HOOGLAND, S.C. AGARWAL.
- 8 An Interdisciplinary Project on the Neolithic Population of Modern Switzerland. I. SIEBKE, A. FURTWÄNGLER, A. HAFNER, J. KRAUSE, S. LÖSCH.
- 9 Anthropological and bioarchaeological approaches to two medieval populations from Reigoldswil (Switzerland). V. TRANCIK PETITPIERRE, A. HAFNER, S. LÖSCH.
- 10 Keep your head high - Mesolithic crania mounted on stakes at Kanaljorden, Sweden. A.S. KJELLSTRÖM, S. GUMMESSON, F. HALLGREN.
- 11 Urbanization's Impact: Health and Survivorship Patterns in Medieval Poland. T.K. BETSINGER, S. DEWITTE.

### Session 70

#### Human Skeletal Biology: Population History and Beyond

##### Contributed Poster Presentations

*Chair: Molly K. Zuckerman*

Acadia

- 1 Two recently excavated Megalithic gallery graves in Erwitte-Schmerlecke (North Rhine-Westphalia) from the Wartberg Culture (3500-2800 BC) with focus on the investigation of their builders. S. KLINGNER, M. SCHULTZ.
- 2 Reconstructing the monastic lifestyle: Bioarchaeological investigation of living conditions in a religious community based on human skeletal remains from el-Ghazali, Sudan. J.A. CIESIELSKA, R.J. STARK.
- 3 Mortality Effects of Discrimination in Post-Medieval Ireland. M.A. CLARK.
- 4 Skeletal Height Estimation in Medieval Bioarchaeological Collections from Piedmont, Italy. N.M. WEISS, G. VERCELLOTTI, R. BOANO, M. GIROTTI, S.D. STOUT.
- 5 Implementing Intersectionality in Bioarchaeology: A Study of Sex and Status at Roman Winchester. L. AVERY, T.L. PROWSE, M.B. BRICKLEY.
- 6 The Rise of an Empire, the Decline of its People: Stature and body proportion in Roman Britain. L.J. WALTHER, R.L. GOWLAND.
- 7 Sexual dimorphism of the upper face, mandible and palate in elite of early medieval population from the Central Europe. Š. BEJDOVÁ, J. DUPEJ, J. VELEMÍNSKÁ, L. POLÁČEK, P. VELEMÍNSKÝ.
- 8 Sexual Dimorphism in an Early Medieval Population (IX.-XI. Century) from Central Europe and its relationship to socio-economic stratification. P. VELEMINSKY, P. STRÁNSKÁ, J. DUPEJ, P. HAVELKOVÁ, S. KAUPOVÁ, J. FROLÍK, L. POLÁČEK, J. BRUZEK.
- 9 Bio-cultural analysis of an early 18th century noble family in Transylvania, Romania. K. ZEJDLIK, Z. NYÁRÁDI, R. SANDQUIST, A. GONCIAR.
- 10 A rocky start: The conundrum of a post-medieval burial ground in Gibraltar. D.L. WARD, E. POMEROY, J. GRANT, S. BENADY, C. FINLAYSON, M. REINOSO DEL RÍO, J. GUTIÉRREZ LÓPEZ, K. LANE.
- 11 Biological distance between flexed and supine burials at the ancient Greek city of Himera using dental nonmetric data. J. CZAPLA, B. KYLE, S. VASSALLO, P. FABBRI, L.J. REITSEMA.
- 12 The Bioanthropology of the inhabitants of the Late Middle to Early Late Bronze Age at Megiddo, southern Levant. M. FAERMAN, M. MARTIN, P. SMITH.
- 13 Assessing the role of migration during a cultural transition (fourth century BC to AD sixth century): Strontium isotope results from Samtavro cemetery, Central Georgia. N. LANGOWSKI, V. PILBROW, R. MAAS.

## SATURDAY AFTERNOON SESSIONS

- 20 Are the socially recognized ethnic groups of northern Pakistan meaningful biological entities for reconstruction of population histories? A dental morphology investigation. M. TARIQ, H. AHMAD, B. HEMPHILL.
- 21 Historic era immigrants to northern Pakistan? A dental morphology investigation of Pathans, Gujars and Kohistanis. I. ULLAH, H. AHMAD, B.E. HEMPHILL.
- 22 Fetal Remains in Bioarchaeology: A Case Study from the 19th Century Spring Street Presbyterian Church. M.A. ELLIS.
- 23 Perinatal death - a multitude of fetal and neonatal burials at the churchyard of Michelberg, Austria. M. BERNER, A. STADLMAYR, D. PANY-KUCERA, E. RAMMER, E. LAUERMANN.
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- 25 Age Related Changes in Trabecular Bone Structure in a Sample of Early Agriculturalists. D.J. KLEBECK, T. RYAN.
- 26 Anterior femoral curvature tracks decreasing mobility from Woodland to Mississippian. A.Y. ABU DALOU.
- 27 Postcranial Robusticity of Two Precolonial Brazilian Coastal Shellmound Builders Groups Relative to Differences on Daily Activities and Mobility. A.D. SALLES, M. KONSKIER, E.T. TONOMURA, A. LESSA.
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- 31 Historic and Skeletal Mortality of the Mississippi State Asylum. A.M. PLEMONS, M.L. DAVENPORT, N.P. HERRMANN.
- 32 Social Status, Skeletal Biology, and the Lords of Sipán: Bioarchaeological Perspectives on the Moche Elite, North Coast Peru. A.C. HAM, H. KLAUS, J. THOMAS, S. BALL, H. HULEY, G. BROWN, J. YOUNG, E. BRACAMONTE LEVANO, W. ALVA ALVA.
- 33 Kinship Structures and Victim Origins in a Mass Human Sacrifice: Biodistance Analysis of Intracemetery Dental Phenetic Variation, Temple of the Sacred Stone, Túcume, Peru. J.E. YOUNG, H.D. KLAUS, J. TOYNE, B. DELGADO.
- 34 The confusing case of Grave 42: a bioarchaeological analysis. C. JAMES, K. FLOR-STAGNATO, E. CANTOR, A.J. OSTERHOLTZ, A. GONCIAR, Z. NYÁRÁDI.
- 35 A comparative bioarchaeological analysis of two Formative Period communities from the lower Rio Verde, Oaxaca, Mexico. A.J. YOUNG, A.T. MAYES, J. BRZEZINSKI, S. BARBER, A. JOYCE.
- 36 The Bioarchaeology Field and the Study of Ancient Egypt - Development and Characteristics of Academic Publications. L.B. FARIA.
- 37 Lost and Found: Forgotten Cemeteries Under the City of Milwaukee. S.A. BONCAL.
- 38 *Ave Imperium! Mortui te salutamus*: Bioarchaeological Research in the Roman Period Black Sea Region, Turkey. K.E. MARKLEIN.
- 39 Does the Number of Nuclear Microsatellite Loci affect Genetic Distances? Implications for Bioarchaeological Studies. A.R. HUBBARD.
- 40 A novel cranial base drilling method with direct access to petrous bones for analyzing ancient DNA and preserving ancient human remains. K.A. SIRAK, D.M. FERNANDES, O. CHERONET, M. NOVAK, B. GAMARRA RUBIO, T. BALASSA, Z. BERNERT, A. CSÉKI, J. DANI, J. GALLINA, I. KÓVÁRI, O. LÁSZLÓ, I. PAP, R. PATAY, Z. PETKES, G. SZENTHE, T. SZENICZEY, T. HAJDU, R. PINHASI.
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- 42 Craniometric variation of Early Horizon Native Californians: New perspectives on the Howells Craniometric Dataset. W.B. REINER, L.J. HLUSKO.
- 43 Intra- and inter-population affinities among the Medieval English: a preliminary craniometric study. S. VALORIANI, J.D. IRISH, S. GONZALEZ, M. BORRINI.
- 44 Mortuary Archaeology of the Pre-Columbian Aklis Site, St. Croix, USVI: Normativity and Deviance. M.K. ZUCKERMAN, D.T. ANDERSON, D.S. MILLER, J. FLORES, S.B. HUDSON, G. WEHRMAN, M. REDONA.
- 45 The Biological Embodiment of Public Health Values: A Case Study from Two Working Class English Populations. S.A. MATHENA-ALLEN.

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- 46 Cultural hybridity and Greek colonization: A case study of Himera utilizing strontium isotope analysis. A.C. KAZMI, L.J. REITSEMA, K.L. REINBERGER, B. KYLE, S. VASSALLO.
- 47 Mobility at Neolithic Çatalhöyük: Temporal and Ontogenetic Context. E.M. GAROFALO, C.B. RUFF, C.S. LARSEN.

### Session 71

#### **Forensic Anthropology and Bioarchaeology: Sex, Comingling, Postmortem Interval, and Decomposition**

##### **Contributed Poster Presentations**

*Chair: Nicholas P. Herrmann*

Acadia

- 1 Measuring bacterial communities in the humerus to estimate PMI. S.E. BIVENS, E. DAVID, N. RUBLE.
- 2 A metric approach to assessing sex in the Erie County Poorhouse Collection. B.A. KENYON, S.E. BAUMGARTEN, J.E. SIRIANNI.
- 3 The accuracy of tibial nutrient foramen vs. midshaft measurement location for sex determination. A.C. DAFOE, D. HUNT.
- 4 Sexual dimorphism of the humerus in a Japanese sample: A test of the İşcan et al. (1998) method. R. BONGIOVANNI, C.B. LEGARDE.
- 5 Biological sex assessment methods: A meta-analysis of trends in recent (2006-2015) forensic and archaeological research. A.B. CHECK, E. CRAIG-ATKINS.
- 6 Estimation of Sex in Fragmentary Archaeological Populations: A Test of Post-Cranial Estimation Methods. M.C. STEWART, G. VERCELLOTTI.
- 7 Sex Determination Using the Proximal Femur: a method for Portuguese Populations. F. CURATE, C. UMBELINO, C. NOGUEIRA, A. PERINHA, E. CUNHA.
- 8 Are metacarpals handy indicators of sex? The applicability of metacarpal metrics in sex determination. K.A. ROBINSON, T.K. BETSINGER, J.M. ULLINGER, D.R. TARQUINIO.
- 9 Sexual Dimorphism of the Capitate using 3D Data. J.V. MEYER, H.J. EDGAR, S. DANESHVARI BERRY, W.F. MARQUARDT.
- 10 Metric Sex Estimation using the Sustentaculum Tali. C.A. BAILEY, K.A. BROEHL, A.C. DUNCAN, A.Z. MUNDORFF, R. KOSALKA.
- 11 Postcranial Sectioning Points Derived from the Terry Collection for Utility in Sex Estimation in Historical Contexts. D.D. GRAHAM, A.K. COSTELLO, K.E. BRUN.
- 12 Reevaluating morphological sex estimation methods for the creation of a free user database. A.R. KLALES, S.J. COLE.
- 13 A multi methodological approach for human identification and reconstruction of cause and manner of death in forensic anthropology. F. KANZ, H. BRANDTNER, E. MÜLLER, F. NEUHUBER, S. TANGL, E. TUTSCH-BAUER, O. ANZBÖCK, J. CEMPER-KIESSLICH.
- 14 Historical Bioarchaeology and DVI: Data Integration of the Mississippi State Asylum Burial Sample and Archival Records. N.P. HERRMANN, M.L. DAVENPORT, A.M. PLEMONS, G.L. HARLEY, A.D. SHAEFER, M.K. ZUCKERMAN.
- 15 Sorting Out the Past: An evaluation of MNI Methods. S. KUISMANEN.
- 16 Harlyn Bay: A Case Study in the Analysis of a Curatorially Commingled Skeletal Collection. A.M. JORDAN.
- 17 Constructing Demographic Profiles in Commingled Collections: A Comparison of Methods for Estimating Age at Death in a Byzantine Monastic Assemblage. R.C. MAYUS, S. GUISE SHERIDAN, C.S. LARSEN.
- 18 Retrospective correspondence analysis of a comingling event. J.L. CAMPBELL.
- 19 Joint articulation in resolving commingled human remains: Osteometric analysis of the acetabulo-femoral and tibio-femoral articular surface areas. E.W. PARKINSON, E. CRAIG-ATKINS.
- 20 Bacterial Succession in Bone Marrow as a Potential Tool for Estimating PMI. C.T. FAKHRI, L. SPOONIRE, N. RUBLE.
- 21 The Use of the Pelvic Microbiome for PMI Estimation. L. RUDIE, M. MANN, N. RUBLE.
- 22 The Effects of Body Composition on Human Decomposition. S.T. AMMER.
- 23 An application of structure from motion to document the decomposition of hacking wounds. C.D. CARLTON, S. MITCHELL.
- 24 Seasonal Differences in Accumulated Degree-days on the Rate of Human Decomposition. S.L. GARZA, D.J. WESCOTT.
- 25 Initial *in situ* bone decomposition after short inhumation times: New insights from experimental degradation assays. N. HOKE, A. ROTT, M. HARBECK.
- 26 Exploring provision of care for disabled individuals in prehistoric Alabama. D.S. SIMPSON.

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- 28 Allometry, sexual dimorphism in human ossa coxae, and its relevance for understanding human torso variation. S. TORRES, D. GARCÍA-MARTÍNEZ, J. EYRE, S.A. WILLIAMS, J. HAWKS, C. VANSICKLE, M. BASTIR.
- 29 Arsenic fed piglets: Assessing arsenic levels in decomposing pig tissue and soil samples. C.L. BROWN, R.R. PAINE.
- 30 A comparative study of the effects of river flow rate on decomposition. M. NEUMAN.
- 31 Microbiome of Bone Marrow during Human Decomposition. N. RUBLE, P. LEWIS, A. LYNNE.
- 32 Sexual dimorphism in absolute and relative sizes of pubis dimensions from a documented human osteological collection. B.N. THOMPSON, F.L. WILLIAMS.
- 33 Using Bacterial Communities From Human Femora To Determine Post Mortem Interval. S.A. BAKER, S.N. MESA, M.N. RUBLE.

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## Dental microwear textures of an expanded sample of *Australopithecus africanus* from Sterkfontein Member 4

ELICIA F. ABELLA<sup>1</sup>, FREDRICK E. GRINE<sup>2</sup>, MARK F. TEAFORD<sup>3</sup> and PETER S. UNGAR<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Arkansas, Fayetteville, AR 72701, <sup>2</sup>Departments of Anthropology and Anatomical Sciences, Stony Brook University, Stony Brook, NY 11794, <sup>3</sup>Department of Basic Sciences, Touro University California, Vallejo, CA 94592

Previous study has suggested that *Australopithecus africanus* and *Paranthropus robustus* have overlapping molar microwear textures, but that *A. africanus* had a greater spread of anisotropy values, whereas *P. robustus* had more variable but a higher average complexity. This was taken to suggest overlapping diets, but more tough-food consumption by *A. africanus* and more hard-object feeding by *P. robustus*. The basis of that original work was a comparatively small sample, including only ten *A. africanus* specimens. Here we present data for an expanded sample, including both Sts and Stw specimens ( $n = 25$  individuals) from Sterkfontein Member 4 with specimens from the previous study, to assess within-species variation in *A. africanus*. We considered only molar teeth, and examined them using standard confocal profilometry and scale-sensitive fractal analyses. Our results for both microwear texture complexity and anisotropy are consistent with the previous study based on the smaller sample. While the new data slightly extend the range of values for anisotropy and complexity, the expanded sample of *A. africanus* still overlaps with that for *P. robustus*, but has a higher average anisotropy and lower average complexity. This suggests, again, that compared with *P. robustus*, *A. africanus* individuals at Sterkfontein consumed more tough foods, and fewer hard, brittle ones in Member 4 times.

This study was funded by a U.S. National Science Foundation grant to PSU, FEG, and MFT

## Male-infant Relationships in Wild Woolly Monkeys (*Lagothrix lagotricha poeppigii*)

LAURA A. ABONDANO<sup>1,2</sup>, KELSEY M. ELLIS<sup>1,2</sup> and ANTHONY DI FIORE<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Texas at Austin,

<sup>2</sup>Fundación Proyecto Primates

Male-infant interactions in primates are associated with male strategies that can reflect paternal investment in offspring, mating effort, or a combination of strategies. Male caretaking is expected to be more prevalent in species with high paternity certainty, maximizing the chances of males investing in their own offspring. More extensive male care is also expected when infants have high risk of mortality, if increased paternal care can improve infant survival. Here, we describe male interactions with infants and their

mothers in wild woolly monkeys at the Tiputini Biodiversity Station, Ecuador. This species is described as having low paternity certainty, low infant mortality, and no reported cases of infanticide, suggesting that male caretaking behavior should be rare. Over 16 months (2014-2016) of observation, we recorded, *ad libitum*, at least 19 cases of intense male interest in infants. These interactions included males inspecting, touching, grooming, carrying, or playing with infants as well as their maintaining frequent spatial proximity (within 2 meters) to mothers carrying infants. Additionally, in male-female dyads ( $N = 32$ ), males were 6.5 times more likely to be in spatial proximity of females with infants than females without infants ( $W = 21$ ,  $p < 0.001$ ), despite the fact that females without infants were more numerous in the group. Our results suggest that male-infant interactions in woolly monkeys may be important, despite low paternity certainty and low infant mortality, and could reflect a male strategy to strengthen social bonds with females and increase future mating opportunities.

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## Anterior femoral curvature tracks decreasing mobility from Woodland to Mississippian

AHMAD YOSUF. ABU DALOU

Anthropology, Yarmouk University

Trends of change in terrestrial logistic mobility has been investigated by several methods, including femoral midshaft shape as determined by external measurements and cross-sectional geometry. This study used anterior femoral curvature and shape of femur at the midshaft to test the hypothesis that mobility decreased significantly as a result of shift from hunting and gathering to agriculture in North America. Femoral curvature develops during childhood and adolescence from the more straight condition at birth. Degree of curvature and shape at the midshaft of femur of 48 skeletons from the Woodland Period and 24 from the Mississippian Period were measured. Findings showed that young people of the Woodland Period who participated in foraging and horticulture displayed a significantly greater degree of femoral curvature than those of the Mississippian Period whose principal subsistence strategy was agriculture.

Sexual dimorphism in curvature was significantly greater in the Woodland than in the Mississippian, a pattern repeated with femoral midshaft shape. Males showed more anteriorly curved femora and antero-posteriorly elongated oval femoral midshafts than females. Simple measurement of the development of anterior femoral curvature in adults as a proxy for mobility holds advantages

over cross-sectional geometry since it does not require sections, radiographs or computed tomography.

## Seasonal Fluctuation in Body Fat Sexual Dimorphism among Pumé Hunter-Gatherers

ALAN ACHENBACH, RUSSELL D. GREAVES and KAREN L. KRAMER

Anthropology, University of Utah

Human females cross-culturally have a greater percentage of body fat than males. Based on studies in developed (stable food) populations, females are expected to be more resistant to weight loss. However, in the majority of seasonal hunger studies in traditional populations, females experience greater weight fluctuation than males. Thus, sexual dimorphism in body fat appears ecologically dependent. To address this, we test the hypotheses that in food-fluctuating populations, females will show both a higher mean and variance in body fat relative to males when food is plentiful. We test this hypothesis in two genetically related South American populations, the Savanna Pumé, a group of mobile hunter-gatherers ( $n=72$ ) and the River Pumé, a group of horticulturalists ( $n=57$ ). The Pumé live in close geographic proximity, have similar life histories and pathogenic exposure, but experience different levels of seasonal variation in food availability. We compare two body fat measures (BMI and triceps skinfold) among reproductive-aged adults during lean and abundant seasons. Results show that 1) Savanna Pumé male and female body fat variance is similar during food scarcity; 2) but female body fat increases significantly and has greater variance during food abundance; 3) and among the more food stable River Pumé, body fat dimorphism is reduced in both intersexual mean and variance. Results imply that body fat sexual dimorphism is linked to the degree of food stability. Females are distinguished by their ability to take advantage of abundant season weight gain, not by resistance to weight loss during lean season.

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## In *Cibus Veritas*: Palaeodietary Analysis of Skeletons from 5th Century BC, Italy

ANDREA N. ACOSTA<sup>1</sup>, KRISTINA KILLGROVE<sup>1</sup>, BETHANY L. TURNER<sup>2</sup> and BENJAMIN J. SCHAEFER<sup>2</sup>

<sup>1</sup>Anthropology and Archaeology, University of West Florida, <sup>2</sup>Anthropology, Georgia State University

The Archaic period (c. 6th-5th BC) of central Italy is a liminal one, representing an increase in urban settlement prior to the rise of Rome. Differences between the earlier Latins and the later Romans are evident in burial practices, but very little

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bioarchaeological analysis of Archaic cemeteries has been done.

This project involves eight individuals from Archaic chamber tombs at the site of Gabii, an early urban center located 15km east of Rome. A combination of biochemical and osteological analyses of these skeletons shed new light on the Archaic diet and lifestyle in central Italy. Palaeodietary (C/N isotope) analysis of rib samples was conducted to answer questions regarding dietary patterns, and these results are combined with historical and archaeological data to provide context for life in Archaic Gabii.

Statistical analysis based on t-tests of adult sample means shows that the  $\delta^{13}\text{C}_{\text{ap}}$  values of the six Archaic adults (-12.3‰ VPDB) are the same on average as adults from urban Imperial Rome (-12.3‰,  $p=.85$ ), but significantly different than those from suburban Imperial Rome (-10.5‰,  $p=.0001$ ) and from suburban Republican Rome (-9.9‰,  $p=.0003$ ). This suggests that the Archaic population buried at Gabii was consuming more  $\text{C}_3$  resources than that of the later suburban population. Ongoing analyses of C and N isotopes from rib collagen further elucidate diet and subsistence at urban Archaic Gabii.

This study therefore provides the first palaeodietary isotope data from the Archaic period in Italy, precursor of Republican and Imperial Rome.

### Sex estimation from dental crown and cervical metrics in a contemporary Japanese sample

DONOVAN ADAMS, MARIN PILLOUD, DIANA MALARCHIK and CHELSEA ARCE

Department of Anthropology, University of Nevada, Reno

Various sex estimation methods exist; however, few are population-specific, which can make estimations of sex across populations problematic. Additionally, sex estimation becomes increasingly difficult with fragmentary remains. This study attempts to address both problems in skeletal analyses by presenting a study in which various dental measurements can be used in a population-specific method to estimate sex.

Data were collected on Japanese individuals (males=75 and females=22) who lived in the late nineteenth to early twentieth century, comprising part of a skeletal collection housed at Chiba University in Chiba, Japan. Maximum crown and cervical dimensions (mesiodistal and buccolingual) were collected on the left dental arcade; the right antimeres was substituted in the case of a missing tooth. Univariate t-tests indicate sexual dimorphism in both crown dimensions of UI2; crown buccolingual dimensions of UC, UM2, LI1, and LC; both cervical dimensions of UI2, UP3, LC; cervical buccolingual dimensions of UP4, UM2, LI1, LP3, LP4; and cervical mesiodistal

dimensions of UC and LM2. A step-wise discriminant function utilizing the cervical buccolingual dimensions of the maxillary canine and mandibular lateral incisor and second molar worked moderately well at classifying individuals by sex (75.9% of original group correctly classified, 59.3% of cross-validated group). Finally, various equations were created to aid in the estimation of sex in the case of an unknown individual. This study highlights the variability in sexual dimorphism between populations and the importance of producing population-specific equations.

### Comparison Between *Parapapio broomi* and *Pp. whitei* from Makapansgat and Sterkfontein, South Africa using Dental Microwear Analysis

LAURA C. ADAY, FRANK L. WILLIAMS and WILLIAM G. ANDERSON

Anthropology, Georgia State University

Cercopithecoid fossils attributed to *Parapapio broomi* and *Pp. whitei* are found at Makapansgat Members 3-4 dated to 2.9 Ma as well as at Sterkfontein Member 4 dated to 2.4 Ma. Size differences are purported to characterize the two taxa, such that *Pp. broomi* and *Pp. whitei* may have occupied distinct but stable dietary niches. To examine whether site or taxon better explains the variation in dietary signals, *Pp. broomi* from Makapansgat ( $n = 8$ ) and Sterkfontein ( $n = 20$ ) and *Pp. whitei* from Makapansgat ( $n = 10$ ) and Sterkfontein ( $n = 20$ ) were examined using low magnification stereomicroscopy with an external light source and a 0.4 mm<sup>2</sup> ocular reticle, using averages of two observations on the paracone or protoconid as a sampling strategy. Comparative samples included *Pp. jonesi* from Sterkfontein ( $n = 20$ ), *Cercocebus agilis* ( $n = 10$ ) and *Colobus angolensis* ( $n = 10$ ). Canonical Scores Axis 1 (64.6% of variance) imperfectly separates Makapansgat and Sterkfontein *Parapapio* suggesting paleoecological differences characterize the two sites. The second axis (28.4% of variance) largely separates *C. angolensis* from *C. agilis* on the basis of the number of fine scratches in the former and large pits and coarse scratches in the latter. None of the *Parapapio* taxa appear to have been folivorous, such as *C. angolensis*, and *Pp. whitei* from Makapansgat and *Pp. broomi* from Sterkfontein may have engaged in hard-object feeding, such as in *C. agilis*. Site rather than taxon may account for more of the dietary variation in Pliocene *Parapapio* of South Africa.

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### Fracture Resistance in the Human Rib: Contributions of Cross-Sectional Geometry

AMANDA M. AGNEW, ELINA MISICKA, MICHELLE M. MURACH, VICTORIA M. DOMINGUEZ and TIMOTHY P. GOCHA

Skeletal Biology Research Lab, Injury Biomechanics Research Center, The Ohio State University

Rib fractures are a common form of trauma in individuals of all ages, and can negatively impact morbidity and mortality. In this study, a hierarchical approach was used to assess variability in rib parameters that contribute to differential risk of fracture in humans. A large sample of mid-level ribs (4-7) from male and females of all ages of skeletally mature individuals (15-108 years) are included in this study. Variation is assessed between individuals according to sex, age, and stature, and is assessed within individuals according to rib levels, location along the rib and cortex (i.e., pleural vs. cutaneous) where appropriate. Results indicate significant ( $p < 0.05$ ) differences between rib levels, location along the rib, and cortex according to individual level characteristics (e.g., sex) for Cortical Area (Ct.Ar), Cortical Thickness (Ct.Th), Robusticity, Section Modulus (Z), and Area Moment of Inertia (I). Additionally, these parameters are significantly correlated with rib structural properties including stiffness and peak force. These relationships suggest differential fracture risk may result from the functional adaptation of the ribs to their local loading environment (i.e., via respiration), as well as systemic, metabolic influences and highlights the degree of variability present across the population.

### Can diaphyseal (cross-sectional) properties of arm and leg bones detect among-population genetic relationships?

GINA AGOSTINI and BRIGITTE HOLT

Anthropology, University of Massachusetts Amherst

The ability of diaphyseal bone to adapt to physical activity is well documented. However, few studies have investigated whether the same properties reflect among-population genetic relationships despite evidence that craniofacial and pelvic dimensions do so well. Craniofacial and long bone data were gathered for 1003 individuals throughout Europe and South Africa. Diaphyseal (cross-sectional) shape and rigidity properties were gathered for the humerus, radius, femur, and tibia. Population genetics methods commonly applied to crania (the "Relethford-Blangero" model) were used to compare the abilities of craniofacial and diaphyseal data to detect population distances. Results show that diaphyseal properties have higher coefficients of variation and lower differentiation (QST) values than do crania. This is consistent with increased plasticity and intrapopulation variation. Despite this, relationship and distance matrices

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show diaphyseal properties consistently and competently parse out genetic affinities, with plotted among-population relationships similar to those produced by the crania. This similarity is corroborated by a Mantel test confirming the genetic distances generated by craniofacial and long bone variables are highly correlated irrespective of their common origin. These results hold across multiple tests designed to probe the behavior/genetics relationship, including analysis of populations from different behavioral contexts and sympatric populations of differing ancestry. These results in aggregate suggest that behaviorally or environmentally induced plasticity does not fully erase the genetic substructure of limb bones, showing promise for future genetic or phylogenetic applications. Furthermore, some control for genetic autocorrelation should be employed for studies reliant upon interpopulation comparisons of long bones prior to making behavioral predictions.

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### Correlated Responses to Selection among Elements of the Cranium and Appendicular Skeleton between Large-Bodied and Small-Bodied Tamarins

ELIZABETH R. AGOSTO and BENJAMIN M. AUERBACH

Anthropology, University of Tennessee - Knoxville

The correlated evolution of the appendicular skeleton and cranium is largely unexamined. The skeletal elements of the skull, neck, and upper thorax share soft tissue and developmental pathways, and so we hypothesize that these elements exhibit shared responses to evolution. If such a relationship exists, we anticipate that correlated responses to evolutionary forces may be related to changes in body size over time. This study utilizes retrospectively estimated selection gradients of four basicranial, three shoulder girdle, and one appendicular dimension to assess the response to selection among these elements between two species of tamarins: large-bodied *Saguinus oedipus*, and the small-bodied *Saguinus fuscicollis illigeri*.

Vectors of estimated selection gradients required to evolve one tamarin species into another were analyzed using the following eight measurements: foramen magnum length and width, condylar length, size of the nuchal region, and the lengths of the scapula, scapular spine, clavicle, and humerus. For each selection gradient, a 95% confidence interval was estimated using a non-parametric bootstrap. Results show correlated responses to selection among cranial and post-cranial elements. Most traits evolved by correlated responses to selection on other traits, most significantly between cranial and

postcranial traits. We show that the basicranium and the scapula and humerus are not independently evolving. While most of the observed responses to selection appear to follow expected changes in body size, the foramen magnum width (for both transitions) and the scapular length (small to large transition) do not, and may be reflective of underlying genetic covariances affecting these traits.

### Effects of Genetics and the Nuclear Family Environment on Shodagor Health

MONICA H. AHSAN and KATHRINE E. STARKWEATHER

Anthropology, University of Missouri

Measures of height, weight, and BMI capture general health status, reflecting issues such as malnutrition and stunting. Assessing sources of variation in these outcomes reveals population-specific variables of importance to health and nutrition. The Shodagor are a semi-nomadic, boat-dwelling community in Matlab, Bangladesh with nuclear family-focused childcare and economic behaviors. Boat-dwelling presents unique challenges (particularly related to childcare), and the Shodagor utilize distinct economic strategies in which women often engage in riskier work outside the home. We analyze the impacts of genetic variation and household socioeconomic variables on height, weight, and BMI among the Shodagor using Bayesian linear mixed models, and we implement an "animal model" framework to estimate heritabilities using complex genealogical relationships. Household-level socioeconomic variables were screened for inclusion in these models using likelihood ratio tests, and the effects of retained predictors on height, weight, and BMI were estimated according to "types" of individuals: children, mothers, and fathers. This enabled us to assess how these predictor variables differentially impact health between the different types of individuals within households. Genetic variation accounts for approximately 66.9% of the variation in height, 50.5% in weight, and 48.6% in BMI among the Shodagor as a population. Predictor variables such as number of children in each household and wife's income percentage have surprisingly weak relationships with health outcomes, whereas average number of years mothers spent breastfeeding and parental education levels have substantial associations with weight and BMI, particularly for fathers.

### Intermarriage and Hybridity at an Ancient Greek Colony: Oxygen Stable Isotope Analysis at Himera in Sicily

VANESSA C. ALARCIA<sup>1</sup>, LAURIE J. REITSEMA<sup>2</sup>, BRITNEY KYLE<sup>3</sup> and STEFANO VASSALLO<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of Nevada, Las Vegas, <sup>2</sup>Department of Anthropology, University

of Georgia, Athens, GA, 30602, <sup>3</sup>Department of Anthropology, University of Northern Colorado, Greeley, CO, 80631, <sup>4</sup>Regional Archaeological Superintendence of Palermo, Italy

This study addresses residential mobility of individuals interred at the Greek colony site of Himera, Sicily (648-409 BCE), using oxygen stable isotope analysis of human tooth enamel. Studies addressing Greek colonization historically have focused on the process of Hellenization, the more or less unidirectional outward flow of Greek people and culture throughout the Mediterranean. However, Hellenization models discount the important role of indigenous populations, including intermarriage, in the creation of hybrid cultures and ethnicities. Co-occurrence of flexed and supine interment styles at Himera hint at intrapopulation cultural differences in this multi-ethnic colony site. To examine whether burial styles were shared among the population, or segregated depending on a person's geographic point-of-origin, we analyzed oxygen stable isotope ratios of 24 adult individuals, testing two null hypotheses: that there are no significant differences in the oxygen stable isotope ratios of skeletons in flexed versus supine graves, and that females and males are equally likely to be local/non-local. Fifteen individuals were determined to be local to the area whereas seven were non-locals. Chi-square analysis revealed no significant sex differences ( $X^2=1.62$ ,  $p=0.2$ ) and geographic origin appears to be unrelated to interment style ( $X^2=0.04$ ,  $p=0.85$ ). This mix of local and non-local males and females in both burial styles, along with material culture at the site exhibiting both Greek and Sicilian elements, point to intermarriage and hybridity in ethnicity at Himera.

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### Dynamics of clans in Human Unilineal populations: a genetic approach

BÉRÉNICE ALARD<sup>1</sup>, GOKI LY<sup>1</sup>, ROMAIN LAURENT<sup>1</sup>, SOPHIE LAFOSSE<sup>1</sup>, CHOU MONIDARIN<sup>2</sup>, GÉRARD DIFFLOTH<sup>3</sup>, OLIVIER EVRARD<sup>4</sup>, FRÉDÉRIC BOURDIER<sup>5</sup>, SAMUEL PAVARD<sup>1</sup> and RAPHAËLLE CHAIX<sup>1</sup>

<sup>1</sup>Eco-Anthropologie et Ethnobiologie, UMR 7206 CNRS, MNHN, Univ Paris Diderot, Sorbonne Paris Cité, F-75016 Paris, France., <sup>2</sup>Faculty of Pharmacy and Rodolphe Mérieux Laboratory, University of Health Sciences, Phnom Penh, Cambodia, <sup>3</sup>Siem Reap, Cambodia, <sup>4</sup>Patrimoines Locaux et Gouvernance, UMR 208, IRD, MNHN, Paris, France, <sup>5</sup>Développement et Sociétés, UMR 201, Panthéon Sorbonne, IEDES, IRD, Paris, France

Societies are often structured into descent groups, such as clans. The descent group affiliation is transmitted either maternally (matrilineal populations) or paternally (patrilineal populations). People of a same descent groups define

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themselves through a common ancestry, on the male (patrilineal populations) or female (matrilineal populations) line. Consequently, women from the same matrilineal clan should be related through their maternal lines while men from the same patrilineal clan should be related through their paternal lines. However, if there is no recent common ancestry and/or if a clan incorporates individuals through horizontal processes, a lower relatedness is expected. In this study, we investigated clan dynamics in four matrilineal and four patrilineal South-East Asian populations using uniparental genetic data. Indeed, the maternally transmitted mitochondrial DNA and paternally transmitted Y-chromosome are powerful tools to explore fine scale sex-specific relatedness patterns. We sequenced the mitochondrial HVS-1 sequence (438 individuals), in addition to 17 Y-chromosome STRs loci (420 individuals). We show that the mitochondrial relatedness within matrilineal clans is higher than the Y-chromosome relatedness within patrilineal clans. This suggests that the descent rule is more strictly respected in matrilineal than in patrilineal populations or that patrilineal clans might be a conglomerate of men from diverse origins. Interestingly, ethnographic observations show that patrilineal clans from the studied populations tend to incorporate men from other villages and clans. Thus, genetic data unveil contrasted dynamics for matrilineal and patrilineal clans in South-East Asia.

### Nutrient limitation and orangutan facilitated nutrient recycling in a peat swamp habitat

SHAUHN E. ALAVI<sup>1,2</sup>, SRI S. UTAMI ATMOKO<sup>3</sup>, MARDIANTO DJINU<sup>4</sup> and ERIN R. VOGEL<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, Rutgers, The State University of New Jersey, <sup>2</sup>The Center for Human Evolutionary Studies, Rutgers, The State University of New Jersey, <sup>3</sup>Fakultas Biologi, Universitas Nasional, Jakarta, <sup>4</sup>Fakultas Pertanian, Universitas Palangka Raya

The ecological role of primates and their effects on forest dynamics have been largely limited to seed dispersal studies, with little attention paid to the other services that primates provide. Some soil nutrients are critically limiting in tropical forests, and large animals are thought to be disproportionately important for the translocation of soil nutrients. We present data on nutrient limitation in a Bornean peat swamp, and orangutans' role in facilitating nutrient recycling. Data were collected at the Tuanan Research Station in Central Kalimantan, Indonesia from 2014-2015. Nutrient limitation was quantified with nutrient addition experiments using root in-growth cores. Nitrogen, phosphorous, and potassium were the experimental treatments and were compared to control cores. After one year, the change in below ground (fine root) biomass for each treatment was measured. Orangutan fecal samples were

collected opportunistically during full-day focal follows, and soil samples were collected prior to nutrient addition experiments. Only phosphorous cores were significantly different from control cores in fine root biomass ( $p < 0.0001$ ), with a 7-fold mean increase due to phosphorous addition. Mean total phosphorous per fecal sample was 2.85 times greater than mean total phosphorous per soil sample. These data suggest that phosphorous is limiting at Tuanan, and that orangutan feces is comparatively rich in phosphorous relative to the native soil. Orangutans are among the largest animal species at Tuanan, and are at a relatively high density. Orangutans are therefore potentially important regulators of soil phosphorous within peat swamps, and thus provide important ecosystem services to these habitats.

United States Agency for International Development; The Center for Human Evolutionary Studies; International Primatological Society, National Science Foundation, Rutgers Department of Anthropology

### Updated chronology for the Miocene primate succession at Abocador de Can Mata (NE Iberian Peninsula)

DAVID M. ALBA<sup>1</sup>, ISAAC CASANOVAS-VILAR<sup>1</sup>, MIGUEL GARCÉS<sup>2,3</sup> and JOSEP M. ROBLES<sup>1</sup>

<sup>1</sup>Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, <sup>2</sup>Departament de Dinàmica de la Terra i de l'Oceà, Facultat de Geologia, Universitat de Barcelona, <sup>3</sup>Institut Geomodels, Grup de Recerca Consolidat de Geodinàmica i Anàlisi de Conques, Universitat de Barcelona

Continued paleontological fieldwork for more than ten years during the enlargement of the Abocador de Can Mata landfill (ACM; els Hostalets de Pierola, Vallès-Penedès Basin, NE Iberian Peninsula) led to the recovery of >60,000 vertebrate remains, including rare faunal elements such as pliopithecoid and hominoid primates. Based on magneto-, litho- and biostratigraphic data, here we report updated estimated (interpolated) ages for the 235 localities (19 with primates) of the 234 m-thick ACM composite stratigraphic sequence (MN6 and MN7+8; middle to late Miocene), to review the timing of the primate succession in this area. Our results indicate that seven magnetozones are included, being correlated to subchrons C5Ar.1r to C5r.2r (ca. 12.6 to 11.4 Ma). Dryopithecine great apes are first recorded at 12.4–12.3 Ma, although most of them (*Anoiapithecus*, *Pierolapithecus* and *Dryopithecus*) cluster between 12.0 and 11.9 Ma, followed by some indeterminate remains between 11.7 and 11.6 Ma. Pliopithecoids first appear at 12.1 Ma, being subsequently represented by *Pliopithecus* between 11.9 to 11.7 Ma. The small-bodied hominoid *Pliobates* is the youngest ACM primate with an age of 11.6 Ma. Although these primates probably overlapped in time, their co-occurrence is only recorded twice: a dryopithecine with *Pliopithecus* at 11.9 Ma, and a

dryopithecine with *Pliobates* at 11.6 Ma. The rare co-occurrence between great apes and small catarrhines might be attributable to sampling biases and/or to their presumed diverging ecological preferences. Detailed analyses of the ACM fauna will hopefully throw new light on this question in the future.

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### Walking in their shoes: A multidisciplinary approach to understanding tarsal coalition in Medieval Exeter

MALORIE E. ALBEE

Department of Anthropology, The Ohio State University

By combining clinical and archaeological data, this study aims to gain a better understanding of tarsal coalition, a supposedly rare congenital condition, through the differential diagnosis and analysis of a skeletal population from Exeter, England. The skeletal sample for this project was drawn from the 1971-72 and 1976 excavations of Exeter's Cathedral Green by the Exeter Museums Archaeological Field Unit. In this sample of 183 individuals, eight individuals exhibiting coalitions of various forms were diagnosed by radiograph. These combined and separate frequencies are quite high for clinical estimations, but in line with other reported archaeological frequencies. Each individual was examined from the pelvis down for any bony changes related to increased muscle mass or degeneration of the joints associated with such a condition, as it was hypothesized that decreased ankle mobility would require changes in the movement of the rest of the lower limb. The result of statistical analysis of tibial metrics was that most patterns existed in dichotomies, which has been attributed to differing behavior of the individual in response to likely pain and stiffness brought on by the coalition. In particular, a matched pairs t-test was used to compare unilateral tarsal coalition with medial-lateral tibial diameter, and the relationship is significant at the 95% confidence level ( $p=0.0063$ ). These data are useful not only in identifying and understanding tarsal coalition and its compensatory changes in skeletal collections, but also can be applied clinically to aid in diagnosis and treatment of a rare condition which currently is only documented radiographically.

### The Microbial Organ is Unlike any Other – Evidence for Conflict in Human-Microbiome Co-Evolution

JOE ALCOCK<sup>1</sup>, ROSA KRAJMALNIK-BROWN<sup>2</sup>, JUAN MALDONADO<sup>2</sup>, ATHENA AKTIPIIS<sup>3</sup> and CLIFF HAN<sup>4</sup>

<sup>1</sup>Emergency Medicine, University of New Mexico, <sup>2</sup>Biodesign, Arizona State University, <sup>3</sup>Psychology,

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Arizona State University, <sup>4</sup>Bioenergy and Biome Science, Los Alamos National Laboratory

Recent research has highlighted the profound influence of resident microbes on their host's phenotype, eliciting the viewpoint that the human microbiome is a forgotten organ. Organ-like function of the human microbiome might evolve if selection acting on the hologenome - a combination of microbial and host genes - yields adaptations that increase the fitness of the composite organism - the holobiont. Because fitness interests of microbes and hosts are not perfectly aligned, conflict is an additional consequence of selection acting on the hologenome. We have proposed that altered eating behavior and energy metabolism is an outcome of host-microbiota conflict over energy and habitat. Our ongoing research is testing whether human food choices are affected by our oral and gut bacteria, and therefore are not a simple matter of willpower. We have tested whether changes in neuropeptides and eating behaviors are linked to functional changes in the microbiome of night shift workers (n=7) and patients with sleep apnea (n=24). Both shift workers and sleep apnea patients have previously demonstrated a preference for calorie-dense "junk" foods. Sleep apnea patients showed a significant relationship between the pathogen containing group Enterobacteriaceae and urinary norepinephrine ( $R^2 = 0.57$ ,  $p = 0.002$ ). This presentation describes these preliminary findings and their implications for the current epidemic of obesity and metabolic disease. New approaches aimed at limiting host-microbiota conflict, including probiotics and time restricted eating, may help reduce the burden of these diseases.

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### Genetic structure of populations from six cities in Iraq based on 15 STRs

SARAH D. ALDEN<sup>1</sup>, MAJEED ARSHEED SABBAH<sup>2</sup> and MICHAEL H. CRAWFORD<sup>1</sup>

<sup>1</sup>Anthropology, University of Kansas, <sup>2</sup>Forensic DNA Center for Research and Training, Al-Nahrain University

15 STRs were sequenced for 1061 individuals from six dispersed cities within Iraq and these data were used to examine whether there is genetic differentiation among the various regions of Iraq. The samples were collected by buccal swabs from laboratory workers and patients at hospitals and private laboratories in each city and amplified at Al-Nahrain University in Iraq using AmpF<sup>®</sup>STR<sup>®</sup> Identifier<sup>®</sup> kit and sequenced at Macrogen Korea. The most frequent alleles in the Iraqi population were: 8 repeats at TPOX (0.510); 12 repeats at CSF1PO (0.329) and D5S818 (0.319); 11 repeats at D5S818 (0.308), CSF1PO

(0.307), and D16S539 (0.306); and 12 repeats at D13S317 (0.304). The largest sample size came from Baghdad (n=354) and this city presented with alleles which were not found in the other cities nor seem common in surrounding countries: 8 repeats at vWA, 11 repeats at vWA, and 16 repeats at FGA. The rarest allele was found in the city of Wasit: 22 repeats at D13S317. Overall results indicate that Iraqi cities are genetically very similar to each other ( $R_{st} = 0.002$ ) with Anbar being the most distinct. However, genetic clusters created with R package *adegenet* were not independent of city assignment ( $p = 0.003$ ) and the DAPC function was able to correctly assign individuals to their city 48.7% of the time using 120 PCs. This reveals that microdifferentiation among these regions is possible at these loci. MDS plots grouped Iraq with other Middle Eastern countries, particularly Iran and Turkey.

### Paleoenvironments and Dietary Adaptation of *Australopithecus afarensis*: A Synthesis

ZERESEY ALEMSEGED<sup>1</sup>, JONATHAN G. WYNN<sup>2</sup> and WILLIAM H. KIMBEL<sup>3</sup>

<sup>1</sup>Organismal Biology & Anatomy, University of Chicago, <sup>2</sup>School of Geosciences, University of South Florida, <sup>3</sup>School of Human Evolution and Social Change, Arizona State University

Paleoanthropologists are mostly preoccupied by questions relating to morphology, behavior, locomotion, phylogenetic position and evolutionary history of the specific hominin taxa they study. Yet, many issues pertaining to patterns in early hominin evolution cannot be fully investigated without a good understanding of the paleoenvironmental setting that at least in part controls the processes of evolution. Fortunately, the proliferation of fossil discoveries and concomitant advances in our ability to interpret paleoecological context of hominins have recently been remarkable. The wealth of fossil material amassed combined with the application of recently developed approaches ranging from ecomorphological methods, to stable isotope studies to finite element modeling have dramatically improved our knowledge.

Still, paleoecological signals derived from diverse approaches are not necessarily congruent. Faunal abundance studies have long been our best proxies to assess paleolandscapes but their limitations are obvious. Hominin dental microwear studies shed light on type and texture of food consumed, yet isotopic data suggest that inferences made based on these approaches are not straightforward. Particularly, diverging dental enamel isotopic signals from species that are otherwise very similar (*Australopithecus anamensis* vs *Australopithecus afarensis* and *Paranthropus robustus* vs *Paranthropus boisei*) underscore the complexity these issues. Fortunately, paleoecologists today are positioned

to explore these questions in an integrated and holistic manner by looking into both consistencies and discrepancies resulting from diverse approaches. Here, we summarize the major gains made over the past decades, comment on the discrepancies and their potential sources, and point to future research directions both in the field and lab.

### Evidence of an Iron Age Massacre at the Sandby borg Ringfort

CLARA ALFSDOTTER<sup>1</sup> and ANNA KJELLSTRÖM<sup>2</sup>

<sup>1</sup>Department of Cultural Sciences, Linnaeus University/Bohusläns museum, <sup>2</sup>Osteoarchaeological Research Laboratory, Department of Archaeology and Classical Studies, Stockholm University

Due to the discovery of five jewelry caches from the Migration period (AD 400 - 550) in 2010, an excavation of the ringfort Sandby borg at the island Öland on the Swedish southeast coast, was undertaken by the Museum of Kalmar. During the excavation the remains of unburied bodies were found inside houses and on the streets. The zooarchaeological record implies that animals were abandoned to starve. Food was still lying by the hearth and luxury items were left exposed.

Sandby borg was seemingly deserted, leaving no one to care for the dead or their belongings, the later bearing witness to vast riches and a strong connection with the contemporaneous declining Roman Empire.

An osteological investigation was made of the human remains. The analysis followed standard anthropological protocol with a focus on trauma and forensic taphonomy (SWGANTH 2011).

The analysis identified at least 21 individuals in all age groups, several skeletons exhibiting perimortem sharp and blunt force trauma. A decapitated young teen allude to the brutality of the event that lead to the individual's death. All blows encountered have been executed from behind or from the side.

The elemental and trauma characteristics imply interpersonal violence but resemble that of a mass execution rather than a battle field. Furthermore, the lack of females calls for interpretation. In this presentation, based on the remains from this "frozen moment", the unique insights into the everyday life of the Migration period, as well as the brutal attack, will be discussed.

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### **Biological Stress Indicators Among Historically Documented Populations (1913-1935): An analysis of Enteseal Changes and Degenerative Joint Disease**

ANNA P. ALIOTO

Anthropology, Western Michigan University

Recent studies about the American past have aimed to examine multiple lines of evidence from different disciplines in order to reanalyze the American lived experience. Despite this, there has been limited research conducted using techniques and methodologies from biological anthropology. The Hamann-Todd Osteological Collection (n=118) consisting of individuals who lived in Cleveland, Ohio and the surrounding county was utilized to understand how the American lived experience impacted the biological stresses of these individuals. The objective was to investigate enteseal changes and degenerative joint disease on the upper limb to reconstruct activity patterns and to test for possible disparities which may represent differing biological stress experiences. The prevalence and distribution (patterning) among site locations of both enteseal changes and degenerative joint disease was scored using standard methodology and interpreted as evidence of biological stress variability and possible changing or different types of activity patterns. Enteseal changes and degenerative joint disease were also analyzed using population sub-groups of sex and biological affinity ("race"). Results indicate that the majority, eighty percent, of prevalence and distribution in enteseal changes and degenerative joint disease between the sub-groups were similar. However, there are instances of particular site locations and muscle groups which demonstrate statistically significant differences and patterning between the sexes and biological affinities, indicative of different life experiences and stresses. This study contributes to biological anthropology as individuals from this collection are historically documented and demographically known samples and could be used as comparative research for other populations where demographic data is less clear.

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### **Combining Indirect and Direct Evidence for the Coevolution of Brain Size and Diet in Primates**

KARI L. ALLEN

Neuroscience, Washington University School of Medicine

Based on the premises that "bigger is better" and that brain tissue is too metabolically expensive to rapidly expand via neutral evolution, many social and ecological factors have been proposed to explain variation in encephalization within extant primates. The comparative approach presupposes that co-variation in an extant dataset indicates that changes in encephalization

occurred in tandem with shifts in ecological niche. However, the fossil record—the only "direct evidence" for primate brain evolution—demonstrates that relative brain size has persistently increased in parallel, both within and among multiple primate subgroups, a fact that is unaccounted for in analyses restricted to extant-only data. Morphological proxies for ecological behaviors, such as diet, are observable in the fossil record, allowing for a more direct analysis of co-evolution between brain size and ecology through geological time.

This study combines direct and indirect approaches to an analysis of co-variation between brain size and diet in primate evolution. Encephalization (residual endocranial volume from a PGLS regression of endocranial volume on body size proxy), body size (skull size, calculated as the first Principal Component of 14 cranio-dental dimensions), and diet category (assessed via molar shear quotient) were examined for correlated evolution in a dataset of 50 extant and 11 extinct primate species, covering a broad range of phylogenetic and ecological groups. The analysis suggests weak, but inconsistent support that brain size co-evolved with diet across primates. Disconnect between the extant-only and combined datasets are discussed in the context of the theoretical basis for analyses of brain evolution.

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### **Defining the "Outsiders": A Biodistance Analysis of Ottoman Communities in Hungary and Romania**

KATHRYN GROW ALLEN and NOREEN VON CRAMON-TAUBADEL

Department of Anthropology, University at Buffalo

Starting in the 14th century, the Ottoman Empire expanded its territory into southeastern Europe. Much debate persists on the roles of conversion and migration in shaping the demography of European Ottoman garrisons. We present here a biodistance analysis of cranial samples from multiple Ottoman cemeteries across Romania and Hungary, in order to assess the extent to which European Ottomans resemble other European or Anatolian populations.

Craniometric data were collected from three Ottoman skeletal series, one from Budapest, a location of high geopolitical importance during the Ottoman period, and two from more distant, hinterland communities. These samples were compared to two geographically-proximate medieval series and a sample from Anatolia. Principal component analyses and multidimensional scaling analysis of biodistance matrices based on size-adjusted craniometric data indicate several interesting results. First, the Ottoman samples do not share strong affinities with either the medieval or Anatolian groups. Second, the Ottoman sample from Budapest is distinct from the two

outlying Ottoman communities. The latter show a closer biological affinity with each other but are more distinctive from the Anatolian series than the group in Budapest. Lastly, in all three Ottoman series, statistical analyses comparing male and female biodistance indicate greater average shape differences between the sexes compared to the medieval and Anatolian series. Our results have implications for understanding the population dynamics of Ottoman expansion into southeastern Europe, an aspect of history rarely studied by archaeologists and biological anthropologists, but significant in light of modern sociopolitical issues relating to the history of Islam in Europe.

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### **Violence and Prostate Cancer Risk: Chronic Health implications of the Challenge Hypothesis for the Southern American Culture of Honor**

LOUIS C. ALVARADO

Anthropology, University at Albany -- State University of New York

Recent data suggests that greater testosterone exposure across the lifespan predicts prostate cancer risk. Accumulating evidence also suggests that unconstrained energy availability, typical of Westernized diets, permits men's steroid physiology to operate at near maximal capacity. Accordingly, the highest rates of prostate cancer are found within developed regions of the world. However, even among well-nourished Westernized populations, considerable variation exists in testosterone values and prostate cancer rates. Formally known as the challenge hypothesis, among vertebrate species, testosterone production is predicted to rise with the intensity of male-male competition. Applied to human males, specifically those with nutritional status able to support chronically elevated testosterone, social environments that place a premium on dominance contests and competitive interactions are hypothesized to aggravate cancer risk. This hypothesis may be particularly salient for the aptly-termed Southern American "culture of honor". Relative to their Northern counterparts, Southern men, especially rural white Southerners, are more accepting of violence as an appropriate recourse to status affronts, exhibit higher homicide rates, and show more pronounced testosterone reactivity to male contests. Available county-level homicide rates (proxy for aggressive social environment) for white males, along with median household income, percentage of the population below the poverty line, percentage over 65 yrs., and rural/urban residence were collected for Northern and Southern states. These variables were regressed on county-level, age-adjusted rates of prostate cancer incidence for white men. Homicide and rural residence

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positively predicted prostate cancer incidence in Southern counties, whereas there was no association observed among Northerners. Future directions will be discussed.

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### Creating Context: Using Non-human Primates to understand the Relationship between Gut Microbes and Human Diet, Physiology, and Health

KATHERINE R. AMATO<sup>1</sup> and CHRISTOPHER A. SCHMITT<sup>2</sup>

<sup>1</sup>Anthropology, Northwestern University,  
<sup>2</sup>Anthropology, Boston University

The human gut microbiota is shaped by host diet and physiology and influences host nutrition and metabolism. Because these interactions affect human health, gut microbiome research relies on animal models to investigate the mechanisms driving host-gut microbe dynamics. However, because human evolution was characterized by multiple shifts in diet and physiology, it is likely that host-gut microbe dynamics are distinct in humans compared to other animals. Here, we show that the human gut microbiota reacts differently to a high-fat, low-fiber (HFLF) diet than that of a model primate, the African green monkey, or vervet (*Chlorocebus aethiops sabaeus*). Humans consuming a HFLF diet (Italy, U.S.) possess a higher relative abundance of Firmicutes and a lower relative abundance of *Prevotella* compared to humans consuming a low-fat, high-fiber diet (LFHF; Malawi, Venezuela, Tanzania). However, a comparison of captive vervets being fed a HFLF diet and wild vervets consuming a LFHF diet demonstrates the opposite pattern. Additionally, predictive metagenomics demonstrate an increased relative abundance of genes associated with carbohydrate metabolism only in the microbiome of humans consuming HFLF diet. Samples from wild vervets with access to human food are being analyzed to eliminate potential confounds associated with captivity. However, these results provide preliminary evidence that the human gut microbiota has unique properties that may be related to modulation of metabolism and fat storage. While it is possible that these properties are simply a result of unique human diet and physiology, we speculate that they may have contributed to the evolution of human physiology.

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### The Effects of Body Composition on Human Decomposition

SASKIA TM. AMMER

Faculty of Science and Technology, Bournemouth University

It is known that many variables influence decomposition and PMI estimation. However, previous studies that have examined the differences in decomposition rates in respect to body size primarily used animal models and presented contradicting results.

A modified version of Megyesi et al.'s (2005) total body scoring system was used to examine the influence of body composition on human decomposition using 35 study subjects at the Texas State University's FARE. A total of 32 phases/time periods were established for three anatomical regions. The phases and time periods of decomposition were examined daily until full mummification occurred and ADD were calculated. These results were further statistically analyzed using a Student's Slope t-test.

The results showed a strong statistically significant correlation between ADD and BMI for seven of the 32 phases and time periods. In the Head's Loss of Tissue phase and the Limbs' Placement until Start of Mummification time period showed a strong statistically significant correlation ( $R^2 = 0.70051$  &  $R^2 = 0.77258$  respectively). The strongest and most prominent correlations were seen in the Trunk: Purge ( $R^2 = 0.77396$ ), Placement until End of Purge ( $R^2 = 0.73464$ ), Caving In ( $R^2 = 0.77991$ ), Placement until End of Caving In ( $R^2 = 0.6888$ ) and Mummification ( $R^2 = 0.71958$ ). The statistical analyzes of how phases and time periods correlate to each other presented that the slopes of the Trunk Mummification & Trunk Placement until Mummification and Trunk Purge & Placement until Purge End phases and time periods do not show a significant difference and are therefore comparable.

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### An unsteady molecular clock in primates

PRIYA MOORJANI<sup>1,2</sup>, CARLOS EDUARDO G. AMORIM<sup>3,1</sup>, PETER ARNDT<sup>3</sup> and MOLLY PRZEWORSKI<sup>1,4</sup>

<sup>1</sup>Department of Biological Sciences, Columbia University, <sup>2</sup>Program in Medical and Population Genetics, Broad Institute of MIT and Harvard, <sup>3</sup>Department of Computational Molecular Biology, Max Planck Institute for Molecular Genetics, <sup>4</sup>Department of Systems Biology, Columbia University

Evolutionary events, such as species splits and the peopling of a new continent, are often dated under the assumption of a steady rate of substitution. This is well justified for neutral substitutions, as long as the mutation rate per year remains constant. Among mammals, however, there is evidence for substantial variation in yearly substitution rates, often associated with differences in generation length and other life-history traits. Since even among closely related primates, there

is substantial variation in such traits, we sought to quantify the extent to which substitution rates vary among 12 primates, including Old World Monkeys (OWMs), New World Monkeys (NWMs), and Apes. We used whole-genome sequence data and controlled for possible effects of biased gene conversion, methylation at CpG sites, and uncertainty in ancestral genome reconstruction. Substitution rates are up to 64% higher in lineages leading from the hominoid-NWM ancestor to NWMs than to Apes. Moreover, there is variation even among Apes: rates are ~2% higher in chimpanzees and ~7% higher in the gorilla than in humans. The extent of rate variation differs among mutation types and is markedly less for CpG transitions. As a consequence, not only the total rate but also the mutational spectrum varies among primates. These findings suggest that events in primate evolution are most reliably dated using CpG transitions. We therefore re-estimated the ape divergence time using only this subset of substitutions, and found it to be 12.1 million years for humans and chimpanzees and 15.1 million years for humans and gorillas.

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### Human parasitism in a comparative context: Are humans exceptionally parasitized?

CAROLINE R. AMOROSO<sup>1</sup> and CHARLES L. NUNN<sup>1,2</sup>  
<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Global Health Institute, Duke University

Understanding how humans compare to and are unique from other primates is a central goal in biological anthropology. We investigated whether evolutionary shifts along the human lineage have resulted in unique parasite richness, specifically testing two hypotheses. (1) Under the hyper-parasitism hypothesis, humans host more parasites than other primates because of contacts with domesticated animals, sedentary lifestyles, and high densities. (2) Alternatively, the cultural benefits hypothesis proposes that human parasitism has been reduced by behavioral and psychological traits like medicinal plant use, hygienic behaviors, and disgust responses. In sheer numbers, humans host many more disease-causing organisms (1415) than any other primate species (maximum 82). However, humans also live across the globe, have enormous populations, and are better studied than any other primate. To predict how many parasites humans are expected to have, we built a statistical model using predictors of parasite richness in non-human primates and phylogeny. To avoid extrapolating beyond the primate data, we focused on parasites in eight human countries. We used Bayesian phylogenetic methods to fit the model. For helminths, we found support

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for the cultural benefits hypothesis (true parasite richness for all 8 countries fell below the mean predicted richness,  $p=0.008$ , binomial test, null probability=0.5). Other results were not significant, but clearly did not support the hyper-parasitism hypothesis (true richness for 6 of 8 countries fell below the predicted mean for protozoa,  $p=0.29$ , and 7 of 8 for viruses,  $p=0.07$ ). Thus, our findings challenge current thinking about how transitions on the human lineage impacted parasitism.

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### Examining the pig in the poke: What happens with stable isotopes in the body tissues of livestock?

DOMINIC F. ANDERS, JULIA AM. KRETZINGER and MARINA A. VOHBERGER  
Anthropology, LMU Munich

The analysis of stable isotopes in physical anthropology was established as an important tool over the past decades. It is also used in several other scientific disciplines such as ecology and forensics. In general, stable isotope ratios serve as natural markers for different transport processes of matter through the geosphere, hydrosphere and biosphere.

In physical anthropology, stable isotope ratios can be used to detect possible migrations or trading of ancient populations or individuals, for the reconstruction of dietary habits, palaeobiodiversity and climatic conditions.

However various species specific physiological and metabolic peculiarities are surprisingly unknown and hence not taken into account during application of this methodology. One such specific concern is the source partitioning of stable isotopic ratios into the different consumers' tissues such as bone, teeth, fur, bristles, blood, and meat.

Therefore, the SPOCK-project (Source partitioning of stable isotopes in the body tissues of livestock) aims to fill this knowledge gap by investigating the distribution and flow of stable isotopes into and within the organism of domestic livestock by conducting several controlled feeding studies on different species. In the first phase the focus is on the analysis of stable strontium isotopes in pigs and chicken which are commonly used for reconstructing migratory events.

First results show that there is a relation between water source, food and body tissue but no influence by underlying soil.

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### Excessive Gestational Weight Gain and Birth Outcomes among American Indians and Alaska Natives

KERMYT G. ANDERSON<sup>1</sup>, PAUL SPICER<sup>1</sup>, MICHAEL T. PEERCY<sup>2</sup> and GRANT SKREPNEK<sup>3</sup>

<sup>1</sup>Anthropology, University of Oklahoma, <sup>2</sup>Department of Health, Chickasaw Nation, <sup>3</sup>College of Pharmacy, University of Oklahoma

Obesity and diabetes are at epidemic levels among American Indians and Alaska Natives (AI/AN), though the mechanisms influencing these outcomes are not well understood. This study examines the relationship between excessive gestational weight gain (EGWG), or gaining more than the American College of Obstetricians and Gynecologists (ACOG) recommendation, and four birth outcomes: premature delivery, low birthweight (<2500g), macrosomia (>4000g), and caesarian delivery. A total of 120,995 singleton births to AI/AN women from 2009-2013 were extracted from U.S. natality files. For comparison, births to whites ( $n=7,295,639$ ), African Americans ( $n=1,817,989$ ), Asians ( $n=809,142$ ), and Hispanics ( $3,405,292$ ) were also included. EGWG is related to pre-pregnancy body-mass index (BMI): among AI/AN, underweight women are the least likely to exceed ACOG guidelines, overweight women the most likely. Among underweight and normal weight women, only AI/AN were more likely than whites to experience EGWG. Among overweight and obese women, however, all non-white groups were significantly less likely than whites to gain excessively. Compared with other groups, AI/AN are the second most likely to have premature delivery (after African Americans), the most likely to experience macrosomia, and the least likely to have a C-section, while low birthweight prevalence among AI/AN is intermediate. EGWG is associated with reduced odds of preterm delivery and low birthweight for all groups, and with increased odds of macrosomia and C-section. While EGWG may be protective against deleterious birth outcomes such as preterm delivery and low birthweight, its association with macrosomia may contribute to obesity and Type II diabetes among AI/AN children.

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### Differential Impacts of Drought on Social and Ecological Adaptations of the Himba Across Local Environments of Kaokoveld

MARY-CATHERINE ANDERSON and ASHLEY HAZEL

Earth System Science, Stanford University

The ongoing drought in Kaokoveld, Namibia is the region's worst ecological crisis in decades and poses a severe threat to the livelihoods of the Himba, a group of semi-nomadic pastoralists that primarily inhabit Kaokoveld. While environmental

impacts of drought are apparent at a regional level, there exists substantial, small-scale heterogeneity in Kaokoveld's local landscapes, which are unlikely to be impacted by drought equally. Furthermore, these distinctive sub-environments comprising the larger environmental mosaic of Kaokoveld may differentially influence the adaptive processes contributing to social structure, social networks, and diffusion processes that take these networks as their substrates. Herein, we investigated whether differential impacts of drought exist across local Kaokoveld landscapes. Using the Enhanced Vegetation Index (EVI) from MODIS satellite data at the peak of the dry seasons from 2009-2015, we found significant spatial clustering of Himba villages with both high and low inter-annual EVI variance, indicating heterogeneity in resilience to inter-annual fluctuations in dry season vegetation across regions. Additionally, we found significant spatial clustering of Himba villages that had a considerably lower EVI in 2015 than the average EVI between 2009-2014, indicating heterogeneity in drought impact across regions. Individuals residing in regions with the lowest dry season EVI were also found to have the smallest herd sizes of all surveyed regions ( $p=0.03$ ), suggesting a possible tradeoff between harsh environments and herd size. These findings indicate the even within a small, cohesive society residing in a narrow geographic range, it is possible that unique ecological adaptations will arise from distinct local environments.

### Niche Separation of Large-Bodied Cercopithecidae at Koobi Fora, Upper Burgi Member

MONYA ANDERSON<sup>1</sup>, STEPHEN R. FROST<sup>1</sup> and EMILY H. GUTHRIE<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Oregon, <sup>2</sup>Human Subjects Division, University of Washington

The number of sympatric large colobines occurring at Pliocene African sites is unmatched in modern environments. This study examines niche overlap among large-bodied cercopithecids known from hominin-bearing Upper Burgi Member of the Koobi-Fora Formation using body mass, fruit/leaves dietary composition, and percent time terrestrial as environmental variables. We compared *Cercopithecoides williamsi*, *Paracolobus mutiwa*, and *Rhinocolobus turkanensis*, along with the large cercopithecine *Theropithecus oswaldi*: the only taxa complete enough for inclusion.

Estimates for body mass and diet composition were compiled from the literature. To estimate percent time on ground 5 forelimb indices from 292 extant and fossil cercopithecoid specimens including 11 colobine (*P. mutiwa* from West Turkana) and 17 cercopithecine taxa were selected based on availability in fossils and for

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being significantly correlated ( $p < 0.05$ ) with terrestriality in extant taxa.

The three fossil colobines are all estimated to be more terrestrial than extant colobines, with *P. mutiwa* more so than the other fossil colobines. The fossil taxa also separate out in other variables: *P. mutiwa* and *C. williamsi* overlap in size and terrestriality, but not diet; *C. williamsi* and *R. turkanensis* overlap in body mass but not terrestriality or diet; and *P. mutiwa* and *T. oswaldi* overlap in size but not diet. Further analyses with more environmental variables are necessary, but niche separation may have contributed to the diversity of large-bodied primates in the Upper Burgi Member of Koobi Fora.

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### Examination of Neandertal maxillary first molar occlusal outlines using Elliptical Fourier Analysis

WILLIAM G. ANDERSON and FRANK L'ENGLE WILLIAMS

Department of Anthropology, Georgia State University

Neandertal permanent maxillary first molars vary in both size and shape. However, whether ecogeography or chronology better explains these differences is unknown. Occlusal outlines of Neandertal maxillary first molar casts from northern Europe (Spy 1, Sclayn and Engis 2), Dordogne, France (La Quina 5), and the Mediterranean (Hortus 8) were extracted through photostereomicroscopy and non-landmark smooth tracing methods, and occlusal areas were measured by calibrated Motic 3.0 microscope cameras. Principal component (PC) scores of elliptical Fourier harmonic descriptors were calculated using SHAPE v1.3, yielding a total of 117 PC scores with nearly 100% of the variance represented by the first four vectors.

A significant correlation exists between PC1 (58.4% of variance) and area, and both represent size in which the smallest (Engis 2), is followed by Sclayn, Hortus 8, La Quina 5 and Spy 1. On PC2 (23% of variance), Sclayn is distinct, whereas on PC3 (12.6%), Hortus 8 is polarized from the others with the exception of Sclayn which is difficult to classify. PC4 separates Spy 1 from La Quina 5 by a small amount of shape variation (5.8%). A cluster analysis of PC scores links Spy 1 and La Quina 5 via the shortest branch length, followed by Hortus 8 whereas Sclayn and Engis 2 are outliers. These results indicate ecogeography poorly explains maxillary first molar occlusal outlines, whereas chronology is a better predictor given the older age and distinctiveness of Sclayn and the clustering of Spy 1, La Quina 5 and Hortus 8 which are more recent.

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### New Tools and Methods for Developing a Geospatial Paleoanthropology

ROBERT L. ANEMONE<sup>1</sup>, CHARLES W. EMERSON<sup>2</sup> and BRETT NACHMAN<sup>1,2</sup>

<sup>1</sup>Anthropology, University of North Carolina at Greensboro, <sup>2</sup>Anthropology, University of Texas at Austin, <sup>3</sup>Geography, Western Michigan University

Paleoanthropology has long been an interdisciplinary science whose practitioners rely on analytical methods and conceptual approaches borrowed from related scientific fields. Increasingly, the location, collection, and analysis of fossils in different field settings have benefitted from the current and ongoing revolution in the geospatial sciences. During the past 5 years, our fieldwork in Paleocene and Eocene deposits of the Fort Union, Green River, and Wasatch formations in Wyoming's Great Divide Basin has utilized a series of such methods to develop a new, geospatially informed paleontology. We discuss these tools, data sets, and analytical methods and demonstrate that they have improved our ability to locate fossils in a remote and large field area. While all of these methods currently have limitations, the near term future potential of geospatial paleontology is substantial.

Unmanned aerial vehicles (UAVs) or drones can be of helicopter or fixed wing design, and can provide high resolution imagery in still or HD video formats of individual localities or entire landscapes. These images can then be utilized by photogrammetry software to create 3 dimensional digital models. In addition to cameras, potential UAV payloads now include miniaturized LIDAR scanners, thermal cameras, or multispectral scanners, allowing investigators to collect a multitude of different electromagnetic signatures that can reveal mineralogy, lithology and other aspects of paleoanthropological interest. By using a combination of drones, medium and high resolution satellite imagery, pixel and object based image classifications, and artificial intelligence algorithms, we have developed predictive models that guide our continued search for early primates.

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### Mapping the Origins of Inter-Population Skin Color Variation with Admixed Indigenous Populations

KHAI C. ANG<sup>1</sup>, VICTOR A. CANFIELD<sup>1</sup>, TIFFANY C. FOSTER<sup>1</sup>, MEE S. NGU<sup>2</sup>, JOHN HAWLEY<sup>3</sup>, MAHANI M. CLYDE<sup>2</sup>, BADRUL M. MD-ZAIN<sup>2</sup>, GERHARD

MEISENBERG<sup>3</sup>, STEPHEN J. OPPENHEIMER<sup>4</sup> and KEITH C. CHENG<sup>1</sup>

<sup>1</sup>Department of Pathology, Penn State College of Medicine, <sup>2</sup>School of Environmental and Natural Resource Sciences, University Kebangsaan Malaysia, <sup>3</sup>School of Medicine, Ross University, <sup>4</sup>Institute of Cognitive and Evolutionary Anthropology, Oxford University

Several genes that are responsible for the lighter skin color in Europeans as compared to Africans has been discovered, but our knowledge of global skin color remains incomplete without the identification of the primary polymorphisms responsible for the lighter skin of East Asians and/or Amerindians. To map those polymorphisms, we searched for populations admixed for either East Asian or Amerindian ancestry and a darker-skinned ancestry. The Orang Asli of Malaysia and the Kalinago of Dominica are the only two populations we found with such an admixture that also lacked significant European admixture that would otherwise confound our analysis. Both groups exhibit large variation in skin pigmentation. DNA samples and skin reflectance measurements were collected from a total of >1000 individuals. Skin pigmentation, expressed as Melanin Index, ranged from 20 to 80 units, averaging 47.6 and 45.8 for the Orang Asli and Kalinago, respectively. We excluded samples with either of the most common European skin color alleles, *SLC24A5*<sup>A111T</sup> and *SLC45A2*<sup>-374F</sup> from our downstream analysis. Admixture analysis of the Kalinago subsample showed 61% Amerindian, 31% African and 8% European ancestry, representing the highest Amerindian ancestry known among Caribbean populations. Albinism in the Kalinago was found by exome sequencing of an albino and an obligate carrier to be caused by a 4bp inversion in *OCA2*. Orang Asli genotyping revealed that the Negritos are distinct, and that the six Senoi subtribes show significant diversity and that a highland Senoi subtribe is distinct from the rest of the Senoi.

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### Simulating effect of starting configuration on diversity in the context of range expansion

NEHA J. ANGAL and CHRISTOPHER R. TILLQUIST  
Department of Anthropology, University of Louisville

Simulations are a critical methodology for testing evolutionary models, and are particularly useful for exploring the impacts of range expansions upon spatial distributions of genetic diversity. Theory predicts loss of diversity in a range expansion. Our previous work demonstrated high carrying capacity, fecundity, and migration attenuate signals of expansion. This current project

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investigates implications of varied starting configurations of range expansions upon spatial distributions of averaged locus patch-wise heterozygosity. Configurations were: a filled grid, all four edges, a u-shape, opposing edges, adjacent edges, a central region, and a corner region. All simulations occurred on a 10x10 grid for 500 generations. Simulation parameters were low growth (0.1), low migration (0.2), and low/high carrying capacity (200/500). Five neutral SNP loci were simulated for each individual within demes, and data were collected in generations 100/250/500. In all configurations each deme had minimally 25 individuals by generation 100. Results were visualized using heatmaps. We found, that of the initial configurations, those starting in the corner or the center gave a pattern characterized by lower overall diversity, whereas in all others, diversity was high overall. These results accord with expectation.

Study of range expansions into continental regions, such as Europe, has occupied anthropological genetics research for decades. Most published simulations testing hypotheses of human range expansion neglected consideration of the effect of starting configuration. Since inferences of range expansion have been made from modern data based on these simulations, this current project has implications concerning the validity of such inferences.

*This work was conducted in part using the resources of the University of Louisville Research Computing Group and the Cardinal Research Cluster.*

### Isotope paleodietary investigations on a Medieval Christian population from the 4<sup>th</sup> Cataract of the Nile River in Sudan

DANIEL ANTOINE<sup>1</sup>, MARCELLO A. MANNINO<sup>2,3</sup> and MICHAEL P. RICHARDS<sup>3,4</sup>

<sup>1</sup>Department of Ancient Egypt and Sudan, The British Museum, London, UK, <sup>2</sup>Department of Archaeology, School of Culture and Society, Aarhus University, Højbjerg, Denmark, <sup>3</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, <sup>4</sup>Department of Archaeology, Simon Fraser University, Burnaby, British Columbia, Canada

The Sudan Archaeological Research Society, in conjunction with the British Museum, conducted rescue excavations at the Fourth Nile Cataract in northern Sudan prior to the construction of the Merowe Dam. Several cemeteries from the Neolithic to medieval period were excavated and a pilot study was conducted to test the potential of the human remains recovered for carbon and nitrogen isotope analyses. The site with the best-preserved collagen was the Late Medieval Christian cemetery 3-J-18, on the island of Mis, in use around 1,000-1,500AD. Human bone collagen was extracted from individuals dating to different phases, although most of the available data is from inhumations dating to Phase II, the

most intense and prolonged. The  $\delta^{13}\text{C}$  values range from  $-12.8\text{‰}$  to  $-8.7\text{‰}$ , suggesting that the people buried at 3-J-18 consumed both  $\text{C}_3$  and  $\text{C}_4$  plants, but that (irrespective of burial type) this mixture was strongly imbalanced in favour of the latter. The mean  $\delta^{13}\text{C}$  value for Phase II is the lowest ( $= -10.5\pm 1.0\text{‰}$ ) of any population investigated to date from Sudan, and the mean  $\delta^{15}\text{N}$  value is among the lowest ( $= 10.9\pm 1.0\text{‰}$ ). These data indicate that  $\text{C}_4$  plants (e.g. sorghum, millet) dominated the diets of the inhabitants of Mis, who consumed little animal protein. Our findings have implications for reconstructing life in the middle Nile valley and the Medieval Kingdom of Makuria.

*The stable isotope analyses were funded by the Max Planck Society (Germany) and research supported by the Institute for Bioarchaeology (British Museum, United Kingdom).*

### Why did *H. erectus* disperse? Tracking variables between fleshed and skeletal individuals to find patterns of plasticity

SUSAN C. ANTÓN<sup>1</sup>, HANNAH G. TABOADA<sup>1</sup>, EMILY R. MIDDLETON<sup>2</sup>, CHRISTOPHER W. RAINWATER<sup>1,3</sup>, TRUDY R. TURNER<sup>4,5</sup>, JEAN E. TURNQUIST<sup>6</sup>, KAREN J. WEINSTEIN<sup>7</sup> and SCOTT A. WILLIAMS<sup>1</sup>

<sup>1</sup>Anthropology & Center for the Study of Human Origins & NYCEP, New York University, <sup>2</sup>Pathology and Anatomical Sciences, University of Missouri, <sup>3</sup>Anthropology, Office of the Chief Medical Examiner, NY, <sup>4</sup>Anthropology, University of Wisconsin, Milwaukee, <sup>5</sup>Anthropology, University of the Free State, Bloemfontein, South Africa, <sup>6</sup>Caribbean Primate Research Center and Department of Anatomy and Neurobiology, University of Puerto Rico, <sup>7</sup>Department of Anthropology and Archaeology, Dickinson College

The rapid spread of *Homo erectus* from Africa, especially into the more temperate climates of Eurasia, has been variously attributed to technological, energetic, and foraging shifts. The temporal and regional anatomical variation in *H. erectus* suggests a high level of developmental plasticity, or the ability to modify development in response to environmental conditions. Developmental plasticity, a key factor in the ability of *H. sapiens* to occupy a variety of habitats worldwide, results in differences in size, shape, and dimorphism across populations. These differences predict regional variation, overall smaller adult sizes, and lower levels of dimorphism in instances of resource scarcity and high predator load. However, determining whether the human pattern of variability is unique and relatively great compared to other widely dispersed nonhuman primates, and whether it can be retrieved from the skeletal record of these taxa is a non-trivial question. As part of a broader study that looks at metric variation in 35 human and nonhuman primate 'populations' from known environmental contexts and 14 time- and space-restricted paleodemes of *H. erectus* and other fossil *Homo*, here we delve deeper into the relationship between

somatic and skeletal variation in recent *Homo sapiens* and *Macaca mulatta*. We find that skeletal measurements track somatic measurements with varying accuracy across different types of variables but with similar patterns in both humans and macaques. Further, skeletal and somatometric variables yield similar patterns of sexual dimorphism within groups, suggesting that inferences about fleshed bodies may be made from carefully chosen skeletal proxies.

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### Undisciplining Desire: Bisexual and Queer Approaches to Science

SAMANTHA M. ARCHER, TONI VILLASEÑOR-MARCHAL and RICK W.A. SMITH  
Anthropology, University of Texas at Austin

Both humans and nonhumans are shaped by complex interactions of biological and social forces, but the study of such forces has long been divided in the academy, where the life sciences study nature, while the humanities study culture. Feminist and queer critiques of science have powerfully demonstrated that these disciplinary divisions have been shaped by implicit assumptions of binary sex in the western academy, where the male/female divide underlies the separation of science from the humanities, nature from culture, and mind from body. Because biological anthropology is located at the intersections of these ostensibly opposing areas of study, there are opportunities for our field to develop more interdisciplinary, biosocial forms of inquiry. Indeed, there has been a long history of evaluating the connections between nature and culture in biological anthropology, but often, these approaches have reproduced hierarchies of knowledge, privileging biological processes and framing culture as an outcome of nature. Such narratives have been intensively shaped by heterosexual, male perspectives, so moving beyond the nature/culture divide depends in part upon diversifying our field. In this presentation, we argue that bisexual and queer perspectives provide new ways of knowing the world that do not take binaries as a given. Focusing on recent developments in bioarchaeology and paleogenomics, we present interdisciplinary case studies that represent vital sites of transformation, where science is being remodeled via bisexual and queer perspectives. In doing so, we will highlight the impact of queer desires in producing new kinds of biosocial knowledge in biological anthropology.

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### The affinities of *Homo floresiensis* based on phylogenetic analyses of cranial, dental and postcranial characters

DEBBIE ARGUE<sup>1</sup>, COLIN GROVES<sup>1</sup>, MICHAEL LEE<sup>2</sup> and WILLIAM JUNGERS<sup>3</sup>

<sup>1</sup>School of Archaeology and Anthropology, Australian National University, <sup>2</sup>Earth Sciences Section, South Australian Museum, <sup>3</sup>Department of Anatomical Sciences, Stony Brook University Medical Center

Although *Homo floresiensis* has been known for 13 years, its phylogenetic status remains highly contentious. Bones that have been placed in the *Homo floresiensis* hypodigm have been interpreted in three ways: that the species is descended from an early hominin lineage; that it is a dwarfed descendant of *Homo erectus*; that the remains are those of anatomically modern humans that had genetic or metabolic disorders.

Here we present the results of parsimony and Bayesian phylogenetic analyses of an expanded morphological dataset comprising a comprehensive range of specimens for *Australopithecus* and *Homo*: *Australopithecus afarensis*, *Australopithecus africanus*, *Australopithecus sediba*, *Homo habilis*, *Homo georgicus*, *Homo naledi*, *Homo ergaster*, *Homo erectus* (Sangiran and Trinil), and *Homo sapiens*. We broaden the range of traits previously applied to the *H. floresiensis* question by including characters from the crania, mandibles, dentition and postcrania. This has not been attempted before and provides an unparalleled database to apply to the problem of the phylogenetic position of this species.

The new data and analyses support the hypothesis that *H. floresiensis* is an early *Homo* lineage and suggest that *H. floresiensis* is a long-surviving relict of an early (>1.9Ma) hominin. A close phylogenetic relationship between *H. floresiensis* and *H. erectus* or *H. sapiens* can be rejected – we conclude that *H. floresiensis* is not derived from either of these species. These results indicate a hitherto unknown hominin migration out of Africa.

This project was funded by The Australian Research Council Discovery Project Scheme (DP1096870).

### Trabecular architecture of the hominoid humerus

JULIA ARIAS-MARTORELL<sup>1</sup>, REBECCA DAVENPORT<sup>2</sup>, TRACY L. KIVELL<sup>1,3</sup> and MATTHEW M. SKINNER<sup>1,3</sup>

<sup>1</sup>Animal Postcranial Evolution Lab, Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent, Canterbury, UK, <sup>2</sup>Department of Anthropology, University College London, UK, <sup>3</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Trabecular bone can respond to mechanical loading, remodeling in relation to load magnitude and joint posture, and thus can be a key source of functional information in relation to primate

locomotion. Trabecular structure of the primate proximal humerus has been investigated by several researchers but often with ambiguous functional signals. Such equivocal results may reflect the true internal morphology, but may also partially reflect methodological limitations, such that only a subset of the trabeculae has been analyzed. In this study, we build upon previous work by quantifying trabecular structure and inferring joint posture in the proximal humerus using a “whole-epiphysis” analysis. We study humeral trabeculae in several extant primates: *Gorilla* [n=6], *Pan* [n=12], *Pongo* [n=8], *Symphalangus* [n=3], and *Ateles* [n=4]. Results indicate that the trabeculae are generally more dense and connected near the articular surface in all taxa. The proximal epiphysis of the African great apes shows higher trabecular bone volume (BV/TV), with *Gorilla* exhibiting thicker trabeculae than all other taxa. Additionally, a superior concentration of BV/TV in Asian apes is consistent with glenohumeral joint position during suspension, but is not as clear in *Ateles* likely reflecting their more diverse locomotor repertoire. African apes generally share a medioposterior concentration of BV/TV, which differs from the remaining taxa, but its functional link to knuckle-walking is not conclusive. Overall, the results show that trabecular structure within the proximal humerus is complex but can provide novel information for investigating locomotor behaviors in living and fossil primates.

This research was funded by the Marie-Sklodowska Curie Project 703608 to JAM, and the ERC Starting Grant 336301 to TLK and MMS.

### Evidence of Prehistorical Atlantic and Pacific Transoceanic Genetic and Cultural Contacts with America

ANTONIO ARNAIZ-VILLENA, ESTER MUÑIZ, CRISTINA CAMPOS, MANUEL MARTIN VILLA and JOSE PALACIO-GRUBER

Immunology, University Complutense. The Madrid Regional Blood Center

Transatlantic cultural (Solutrean North Spain/France) and/or gene exchanges have occurred between America First Inhabitants and people coming from Atlantic Europe, Pacific Ocean and America in prehistorical times. We have studied Amerindian, European and World wide populations for autosomal HLA genes which account for both human genera genetic history. HLA DNA typing has been done by standard methodologies. 14,430 Chromosomes have been studied from our own data base: 1) Relatedness studies with HLA genes in Aymara (Titikaka Lake Area First Inhabitants, Bolivia) and other Amerindian, Asian Pacific Islanders and Mediterranean populations have been performed by using Arlequin software programs for obtaining genetic distances and Neighbour Joining trees. Also, correspondence analyses among populations were carried out, 2) Alberite Dolmen (Cadiz, southern, Spain) and

Titikaka Lake Tiwanaku culture characters, particularly those related to ritual sound amplification artifacts were found. Our conclusions are: a) Pacific Easter Island (Chile, 2,182 miles far from mainland) cultural and HLA genetic contacts seem to be evident with Tiwanaku (Bolivia) culture; this supports Tor Heyerdal expeditions conclusions (KonTiki, 1947) about South America and Easter Island contacts in antiquity, b) Genetics needs to be contextualized. In the frame of other knowledge areas, like Physical Anthropology and Archaeology in order to obtain more information about World populations origins and Americas peopling.

Finally, Genetics by itself have been unable to satisfactorily explain population relatedness up until now, particularly regarding to Americas peopling: a integrative view of Pacific and Atlantic Oceans genetic and cultural relationships between Pacific Islands, Americas and southern West Europe (Iberians) and British Isles (Celts) in prehistoric time is discussed.

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### Cathemerality in Crowned Lemurs and Sanford's Lemurs: Evidence From Analabe Gallery Forest in Northern Madagascar

KATHERINE ARTHUR and BENJAMIN FREED  
Anthropology, Sociology, and Social Work, Eastern Kentucky University

Cathemerality, a trait found in nearly all Lemur/Eulemur species, may have provided lemur species with a means by which they could reduce interspecific competition, cope with unpredictable environments, or perhaps even reduce predation risk (Curtis 2004). One lemur community in which cathemerality was not readily observed is that of crowned lemurs (*Eulemur coronatus*) and Sanford's lemurs (*Eulemur sanfordi*) of Mt. d'Ambre, a large primary forest (Freed 1996). In June – August 2016, we collected 180 hours of quantitative behavioral data of a sympatric community of these species in Analabe, a small gallery forest. We hypothesized no differences in the species' dry season activity budgets, sleeping site preferences, and daily path length. We observed: 1) both species were highly nocturnal when Ceiba pentandra trees were in flower, but otherwise had similar activity budgets to those in Mt. d'Ambre; 2) unlike Mt. d'Ambre, both species preferred to rest in dense cover; and 3) not unlike Mt. d'Ambre the lemurs' average daily path length differed significantly (greater than 100 meters). Cathemerality in Analabe serves as a means by which the lemurs can cope with a habitat that is limited in the amount of large, concentrated arboreal food patches. Cathemerality tended not to reduce interspecific competition, as both species frequently formed polyspecific associations,

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alerted each other of predators, and fed together. Differences in cathemerality between the two sites serve as evidence of remarkable behavioral variation in *Eulemur*, a strategy that has allowed some species to cope with tremendous habitat change.

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### Comparison of the Oral, Rectal, Vaginal, and Penile Microbiome in Semi-free Ranging Eastern Chimpanzees (*Pan troglodytes schweinfurthii*)

ABIGAIL E. ASANGBA<sup>1,2</sup>, LAWRENCE MUGISHA<sup>3</sup>, KAREN E. NELSON<sup>4</sup>, STEVEN R. LEIGH<sup>5</sup>, BRENDA A. WILSON<sup>2,6</sup>, BRYAN A. WHITE<sup>2,6,7</sup> and REBECCA M. STUMPF<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, Urbana, IL, USA, <sup>2</sup>Carl R. Woese Institute for Genomic Biology, University of Illinois at Urbana-Champaign, Urbana, IL, USA, <sup>3</sup>College of Veterinary Medicine, Animal Resources & Biosecurity, Makerere University, Kampala Uganda, <sup>4</sup>Genomic Medicine Group, The J. Craig Venter Institute, La Jolla, CA, USA, <sup>5</sup>Department of Anthropology, University of Colorado-Boulder, Boulder, CO, USA, <sup>6</sup>Department of Microbiology, School of Molecular and Cellular Biology, University of Illinois at Urbana-Champaign, Urbana, IL, USA, <sup>7</sup>Department of Animal Sciences, University of Illinois at Urbana-Champaign, Urbana, IL, USA

The study of the primate gut and vaginal microbiomes has served as a critical tool in understanding the impact of bacterial communities on the health of both non-human primates and humans. These bacterial communities have been found to play a number of significant roles in the host organism. These include providing the necessary metabolic pathways for the breakdown of fibers, supplying gut lining with nutrients and serving as a source of proteins as well as protection from hostile competitors. They have also been found to be associated with a number of metabolic, auto-immune, and infectious human diseases. In this study, we collected and analyzed matched oral, rectal and penile/vaginal swabs from 31 semi-free ranging eastern chimpanzees (*Pan troglodytes schweinfurthii*). Using 16S rRNA sequencing, we compared the bacterial communities found in these different body sites. Preliminary results show a clustering of bacterial communities by body site, similar to the site clustering found for human microbiomes. We found greater inter-individual variation among the vaginal and penile bacterial communities in comparison to the much smaller inter-individual variation observed among the bacterial communities from the oral and rectal sites. Studies of the microbiome of chimpanzees permit a greater understanding of the variation and function of microbes across the body, support the uniqueness of an individual's microbiome and its possible use in medical diagnosis and forensics, and serve as an invaluable point of comparison to the human microbiome.

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### Experimental Study of Sheep (*Ovis aries*) Bone Weathering Under UV-B Light

SEWASEW HAILESELASSIE

Anthropology, University of Colorado Denver

Bones prior to their incorporation into the fossil and archaeological assemblages undergo extensive surface alterations, which can macro- and microscopically be observed and quantified. In this paper, I report on observed actualistic skeletal tissue decomposition of two Bovines (*Ovis aries*) caused by constant UV-B light exposure. The experimental study was conducted over a five-week period using skeletal elements (n = 30) composed of radioulnai, humeri, femora, calcanei, astragali, naviculars, scapulae, and tibiae. The experimental setting controlled for temperature, humidity, soil properties, vegetation and taxon. The project was set up to test the effect of UV-light on bone surface and determine taphonomic signatures (weathering and decomposition). Behrensmeyer's (1978) weathering stages approach was used to quantify bone surface modification. Evaluation of weathering and quantification of bone surface modification (percentage) was recorded weekly. Skeletal elements displayed similar weathering while exposed to UV-B light as they had been reported in previous studies exposing them to sunlight. Variation in the rate of weathering was also observed between different skeletal elements. However, incremental increase of bone surface weathering was not consistent from week to week. This project expands our understanding of solar radiation's effect on skeletal decomposition and adds to discussions of information inferred from surface weathering. This study supports the argument that assemblage formation and duration of exposure can be acquired from bone weathering.

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### Dead end evolutionary lineage, says the White man: the evolution of *Homo erectus* and *Homo sapiens* in Asia

SHEELA G. ATHREYA

Anthropology, Texas A&M University

The role of Asian populations in models of Middle and Late Pleistocene hominin evolution has historically been framed in two ways. Before 1948, the predominant view was that East/Southeast Asian *Homo erectus* was a "prehominid" species ancestral to *Homo sapiens*. After 1948 with the publication of Movius's monograph, Asia was treated as a "marginal region of cultural retardation" that played no role in the evolution of *H. sapiens*. The perpetuation of this perspective into the late 20th and early 21st century has had the effect of marginalizing the Asian data in global models of human evolution. Perhaps more importantly, the contributions of scholars from the region have been viewed with skepticism, thus effectively keeping their voices

from contributing to an understanding of our evolutionary history. In keeping with the theme of the symposium, this presentation will discuss the implications of these events on two levels: first, in terms of how they impacted the developing narrative of human evolution; and second, in terms of how they reflect biases in the way Western physical anthropologists conduct scientific research. A proposal for opening the science of paleoanthropology to a broader regional and cultural range of scientific perspectives is offered.

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### Tiny Old Dead Human-Like Animals Found in Rocks and What They Tell Us about How Life Changes Over a Long Time

AMY L. ATWATER and E. C. KIRK

Department of Anthropology, University of Texas at Austin

The Friars, Santiago, and Mission Valley Formations in San Diego County are composed of fluvial sediments that yield fossils from the Uintan land mammal age. Omomyine primates currently recognized from the Uintan formations of San Diego County include *Dyseolemur*, *Chumashius*, *Omomys*, *Hemiacodon*, *Washakius*, *Macrotarsius*, *Yaqui*, *Stockia*, and *Ourayia*. Here we describe new primates from the Middle Eocene Friars Formation. Eighteen specimens represent a new omomyoid genus, "Genus A." Dental measurements reveal that Genus A is significantly smaller than *Omomys carteri* but larger than *Dyseolemur*. The upper molars of Genus A lack a pericone and lack a continuous lingual cingulum. Twenty-nine specimens represent a second new omomyoid genus, "Genus B." Genus B is significantly larger than *Omomys carteri* but smaller than *Macrotarsius*. Genus B has an upper fourth premolar with a mesio-buccally oriented protocone. Genus B exhibits upper molars with moderate exodaenodonty and a continuous lingual cingulum. The dental characters of the new genera suggest a close relationship to *Omomys*. Numerous small anaptomorphine species thrived during the preceding Bridgerian land mammal age. However, by the beginning of the Uintan, only one anaptomorphine (*Trogolemur*) remained. By contrast, omomyines diversified from the Early Bridgerian to the Uintan. Accordingly, anaptomorphines and omomyines appear to exhibit opposite trends of species richness over time during the Middle Eocene. The discovery of two new genera from the Friars Formation enhances the known diversity of omomyines during the Middle Eocene and provides further evidence for this observed shift in Eocene primate richness.

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### Differences in Adult Female Human True Pelvis Morphology with Respect to Age are Not Due to Selection

BENJAMIN M. AUERBACH  
Anthropology, The University of Tennessee

Recent studies call into question whether human pelvic morphology reflects evolutionary tradeoffs suggested in the obstetrical dilemma, in which responses to competing selection pressures for obstetrical sufficiency and locomotor efficiency shape the pelvis. Nevertheless, dimensions of the true pelvis likely evolved in response to selection pressures for parturition of large fetuses. Thus, females with narrow bony birth canals may have encountered difficulties in childbirth in the past, even though recent research shows that fetal size and maternal size covary, lessening the possible selection pressure that might result from mismatches in fetal and maternal size. In studies of skeletal remains from multiple archaeological sites, age-at-death in females is correlated with dimensions of the true pelvis, with younger females exhibiting narrower dimensions, a pattern not observed in males. Here, I examine whether selection motivated the relationship between female age-at-death and true pelvis dimensions.

Fourteen linear pelvic dimensions were measured from the skeletons of 327 adults (188 females, 139 males) associated with six late Holocene Native American archaeological sites. Individuals were aged into two categories: "young" (approximately 25 years old and younger), and "not young" (approximately older than 25 years). Measurements were mean-scaled within sex-and-age groups. If there were selection against young females with narrow dimensions, the variance for younger females should be greater than within not young females. Comparisons show no differences in variance between age groups. Further analysis indicates that the pelvis continues to grow throughout early adulthood, but this growth is not driven by any single region of the pelvis.

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### OsteoSurvey: An Open-source Data Collection Tool for Studying Commingled Human Remains

ANNE E. AUSTIN  
History, Stanford University

OsteoSurvey is an open-source set of forms that work with Open Data Kit (ODK) to enable bioarchaeologists to record observations on commingled human remains using Android-based mobile devices. OsteoSurvey introduces several key features that streamline data collection, standardize collected data to enable future reuse, and link data with existing ontologies to

connect our research within and outside the discipline.

This poster presents how OsteoSurvey can be used by bioarchaeologists interested in digital data collection as well as recommendations for ways modular data collection and ontologies can be used to encourage reuse of bioarchaeological data. OsteoSurvey's data collection forms are built using modules based on published standards. A modular collection form enables researchers to (1) clearly delineate the methods used during data collection, (2) combine any number of methods, and (3) easily customize a data collection form to record site- or project-specific data.

OsteoSurvey also employs two web-based ontologies, Uberon and the Human Phenotype Ontology (HPO), to enable future comparison and reuse by linking terms and concepts used in bioarchaeology. Uberon is an ontology of anatomical structures, which is particularly advantageous for fostering interconnections between bioarchaeologists publishing in different languages.

The HPO identifies and relates phenotypic variations, such as spina bifida occulta. The HPO has the potential to link osteological research with research on human phenotypic variation in other disciplines. While these ontologies would require widespread adoption to be fruitful, they offer a new method for bioarchaeologists to link their research both within and outside the discipline.

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### A comparative analysis of wild non-human primate gut microbiomes

RITA M. AUSTIN<sup>1</sup>, KRITHIVASAN SANKARANARAYANAN<sup>1</sup>, CHRISTINA WARINNER<sup>1,2</sup> and CECIL LEWIS JR.<sup>1</sup>

<sup>1</sup>Anthropology, The University of Oklahoma,  
<sup>2</sup>Archaeogenetics, Max Planck Institute for the Science of Human History

Gut microbes have coevolved with their primate hosts and impart microbe-dependent abilities related to immunity, digestion, and behavior. Because microbes interact with, and are selected for, by the host, characterizing the diversity and structure of the gut microbiome is essential for understanding primate evolution and health, especially when considering conservation strategies. The majority of non-human primate (NHP) microbiome studies have focused primarily on great apes and captive primate populations. However, the gut microbiome has been shown to undergo significant changes under captive environments, making studies on wild NHP populations necessary.

Here, we describe the gut microbial community diversity of two New World NHP species, *Alouatta palliata* (n=15; Nicaragua), and *Callithrix spp.* (n=18; Brazil). We extracted DNA from fecal samples, amplified the V4 region of the 16S rRNA gene, and generated microbial community profiles

using high-throughput Illumina sequencing. We then compared these communities to previously published datasets for *Pan troglodytes* (n=160; Tanzania), *Pan paniscus* (n=70; Democratic Republic of Congo), and *Gorilla gorilla* (n= 186; Cameroon).

Across NHP species, the gut microbial community was dominated by members of the phylum Firmicutes (~44%), followed by Actinobacteria (~16%), and Bacteroidetes (~15%). Several microbial taxa showed strong association among host species (FDR adjusted p<0.0001); *Bifidobacterium* with *Callithrix spp.*, Cerasicoccaceae with *Alouatta palliata*, Coriobacteriaceae with *Pan troglodytes* and *Pan paniscus*, and *Acinetobacter* with *Gorilla gorilla*.

Further functional analyses of these microbes will prove valuable to understanding their impact on the immunity and health of their primate hosts in both wild and captive environments.

Funding was provided by the University of Oklahoma Graduate College.

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### Discerning Hominid Taxonomic Variation in the Southern Chinese, Peninsular Southeast Asian, and Sundaic Pleistocene Dental Record

TOBIAS R. AVALOS  
Anthropology, The University of Iowa

Pleistocene hominid dental remains from East Asia that have not aligned with the known extinct Asian great apes in size or morphology have been difficult to classify. Therefore, a more thorough state of the art analysis through modern geomorphometrics, comparing living and extinct humans and Asian great apes for the first time, was performed. This unprecedented landmark-based geomorphometric analysis on high resolution images of the occlusal surfaces of molars and premolars attributed to extinct and living East Asian hominids was undertaken in order to test the validity of these specimens' *a-priori* assignments, particularly those previously placed within Homininae. This study revealed that some of the teeth from southern China and the Southeast Asian Peninsula originally classified as early human were non-human ape in origin, and that teeth originally assigned to invalid hominid taxa, such as "*Hemanthropus*", are representative of either the "Mystery Ape," *Pongo*, or another taxon. This study refutes hominid assignment for key specimens previously classified as early East Asian hominins, maintaining support for the site of Dmanisi as yielding the earliest evidence of humans outside of Africa; not East Asia. This study presents a more accurate systematic model for Early Pleistocene hominid evolution, affirming the presence of additional Hominidae taxa in the Pleistocene Southeast Asian Mainland, while giving us a much clearer understanding of the composition paleoecology

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and regional distribution of the Pleistocene great ape communities of East Asia.

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### Implementing Intersectionality in Bioarchaeology: A Study of Sex and Status at Roman Winchester

L CREIGHTON AVERY, TRACY L. PROWSE and MEGAN B. BRICKLEY

Anthropology, McMaster University

There is increasing awareness that human lives are multidimensional, and cannot be explained or understood through one facet of identity. Within bioarchaeology, however, studies tend to focus on inequalities of sex or social status independently, and rarely consider multiple aspects of identity concurrently. This research uses the feminist framework of Intersectionality to incorporate multiple aspects of identity simultaneously, during an analysis of dietary inequalities in 342 skeletons from Roman Winchester (4<sup>th</sup>-5<sup>th</sup> century CE). Rates of antemortem tooth loss (AMTL), dental caries, and dental wear were analyzed by sex and social status, independently and concurrently, to explore how these aspects of identity influenced dental health variables, indicating possible dietary differences.

Males and females exhibited statistically significant differences ( $p < 0.05$ ), with males having higher rates of anterior AMTL and dental wear. Differences were also evident between status groups, with lower status individuals have higher rates of posterior and total AMTL. When sex and status were considered concurrently, higher status males and females exhibited no differences, while differences were present between lower status males and females. In the lower status groups females had lower rates of anterior AMTL, anterior dental wear, and posterior dental wear. Dental caries rates did not differ between sex or status groups.

These results suggest that dental health, and therefore likely dietary inequalities, were dependent on more than one aspect of identity. By incorporating multiple aspects of identity, bioarchaeologists may be able to better understand inequalities and diversity within past human experiences, and Intersectionality can assist in elucidating this variation.

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### Comparative Morphometric Analysis and Digital Reconstruction of the *Homo floresiensis* Pelvis

KAREN L. BAAB<sup>1</sup>, MATTHEW C. O'NEILL<sup>2</sup>, ASHLEY S. HAMMOND<sup>3</sup> and WILLIAM L. JUNGERS<sup>4</sup>

<sup>1</sup>Department of Anatomy, Midwestern University,

<sup>2</sup>Department of Basic Medical Sciences, University of

Arizona College of Medicine - Phoenix, <sup>3</sup>Department of Anthropology and CASHP, George Washington University, <sup>4</sup>Association Vahatra & Department of Anatomical Sciences, Stony Brook University

Pelvic remains from the type specimen of *Homo floresiensis* (LB1/7) may be informative about the evolutionary affinities and locomotor repertoire of this enigmatic hominin, but have yet to be analyzed morphometrically. Here, we analyze the preserved anatomy using 3D geometric morphometrics and attempt a series of digital reconstructions of a full os coxa.

We collected a 3D landmark dataset from a sample of modern humans and fossil hominins tailored to the partial left os coxa of LB1, which lacks portions of the iliac crest and pubis. Principal components analysis indicated that modern humans are differentiated from early australopiths (*Australopithecus afarensis*, *A. africanus*) along the primary axis of shape variation, with *H. floresiensis* approximately equidistant to these two groups. *H. floresiensis* was more distinct from two large-bodied early *Homo* specimens along this axis, as well as from the Kebara Neanderthal and *A. sediba*, which were overlap the *H. sapiens* range. This component captured variation in ischial tuberosity shape and iliac blade flare.

To reconstruct the missing portions of the ilium and pubis, complete os coxae of *A. afarensis* (AL 288-1), *A. sediba* (MH2) and a small-bodied *H. sapiens* were warped to the shape of LB1 based on the regions of morphological overlap. Additional landmarks from the iliac crest and pubis resulted in better separation between modern humans and the full fossil sample. The two australopith-based reconstructions grouped together despite the different morphology of *A. sediba* and *A. afarensis*, while the human-based reconstruction fell at the periphery of the modern human range.

We acknowledge ARKENAS for access to the fossil specimens.

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### Characterizing Non-Maternal Infant Care in a Communally Breeding Primate, *Varecia variegata*

ANDREA L. BADEN

Anthropology, Hunter College of City University of New York, Anthropology & Biology, The Graduate Center of the City University of New York, NYCEP, New York Consortium in Evolutionary Primatology

Previously, we documented communal infant care in black-and-white ruffed lemurs (Baden et al. 2013). We found that communally nesting mothers spent more time feeding and experienced greater infant survival. We attributed a female's tendency to crèche infants in part to kin relations within the community, but also to the mutual benefits gained from crècheing (e.g., higher infant survival). These explanations cannot,

however, easily explain why non-mothers also participated in care. Here, I aim to further characterize the communal breeding strategies (i.e., allomaternal care, AMC) in black-and-white ruffed lemurs (*Varecia variegata*), a seasonal breeder with facultative AMC. Data presented here were collected from one ruffed lemur community (N=24 individuals) at Mangevo in Ranomafana National Park, Madagascar during 12 weeks of observation (October-December 2008; N=804 hours). AMC first occurred at approximately three weeks post-parturition. Sixteen of 24 community members (66.7%; 8 females, 8 males) were observed in proximity to a nest during the study period. Of these, only 11 individuals (68.8%) provided some form of AMC, including nest guarding, grooming, huddling and playing. Helpers varied significantly in their contributions to AMC (Kruskall Wallis,  $H = 0.267$ ,  $p = 0.003$ ). Adult males were the primary AMC providers (mean=18.67%  $\pm$  16.6 SD, range=0-41.84%), followed by mothers (mean=15.17%  $\pm$  12.27 SD; range=0-37.28%), and non-reproductive adult females (N=1, 3.57%); juvenile males did not help. Mothers averaged 3.00 helpers at the nest ( $\pm$  1.41 SD; range=1-4) and helper number was unrelated to the total AMC infants received (Spearman rank,  $r_s = 0.447$ ,  $p > 0.05$ ).

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### How subjectivity strengthens research: Developing new approaches to anthropological genetics in the Pacific Northwest

ALYSSA C. BADER<sup>1</sup> and RIPAN S. MALHI<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>Carl R. Woese Institute for Genomic Biology, University of Illinois at Urbana-Champaign

Scientific fields, including biological anthropology, are often framed by Western academia as conducting objective research. In fact, this is a core tenant of the scientific process: good science achieves experimental results that are replicable by any researcher. However, the assumption that science is, or can be, objective is flawed and overlooks the significant contributions that can be made by embracing the inherent subjectivity introduced by the perspective of the researcher. In biological anthropology and beyond, the values of the researcher influence the entirety of the scientific process, from the research questions asked to methods used. This presentation provides an example of how research in biological anthropology can be strengthened through the uniqueness of researchers' connections to or interactions with the communities or populations they study. We discuss examples of how, when conducting genomic research with indigenous

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communities (living and ancient) from the Pacific Northwest coast, we employed methods and analyses such as incorporating oral history and community knowledge into interpretations of genomic data, utilizing less destructive methods of ancient DNA analysis, and advocating for and incorporating community consultation and engagement in paleogenomic research. This presentation demonstrates how, in research, embracing the subjectivity and wealth of new research perspectives that academics with diverse backgrounds bring to biological anthropology will enhance the depth of knowledge in our field.

Funding provided by the Office of the Vice Chancellor for Research, University of Illinois at Urbana-Champaign

### Evidence of higher maternal investment for sons in wild chimpanzees at Ngogo, Kibale National Park, Uganda

IULIA BADESCU<sup>1</sup>, ANNE M. KATZENBERG<sup>2</sup>, DAVID P. WATTS<sup>3</sup> and DANIEL W. SELLEN<sup>1</sup>

<sup>1</sup>Anthropology, University of Toronto, <sup>2</sup>Anthropology and Archaeology, University of Calgary, <sup>3</sup>Anthropology, Yale University

Maternal investment through lactation effort can affect reproductive rates and offspring survival in mammals and can be biased towards infants of one sex. Whether sex biases occur in chimpanzees remains largely unexplored. We compared behavioral indicators of weaning (infant age at last nursing bout and first maternal rejection observed) and a physiological indicator of maternal contribution to age-specific infant diet (mother-infant differences in fecal stable nitrogen isotopes,  $\delta^{15}\text{N}$ ) for male ( $N = 26$ ) versus female ( $N = 22$ ) infants among *Pan troglodytes schweinfurthii* at Ngogo. We predicted that mothers would invest more in sons through later weaning and greater infant age-specific lactation effort, based on the assumptions that male philopatry means mothers can have more influence on the reproductive success of sons than daughters and that the potential for high reproductive success is greater for male than female offspring at Ngogo, a site with relatively high food abundance and low feeding competition. Kaplan-Meier survival analyses of age-specific differences by infant sex in the timing of weaning behaviors showed that male infants stopped nursing and received maternal rejections later than female infants (Breslow:  $P < 0.05$  and  $P < 0.01$ ). Generalized Estimating Equations analyses showed that mother-infant differences in  $\delta^{15}\text{N}$  were greater for infant males than females ( $P < 0.05$ ), which indicates that lactation effort of mothers with sons was higher because milk contributed more to males' age-specific diets. Mothers seemed to invest more heavily in infant sons than daughters, which may be a strategy to maximize their own inclusive fitness.

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### Complex mandibular molar root size differences and similarities between non-human primate species (*Gorilla*, *Pongo* and *Pan*), and chimpanzee subspecies (*Pan troglodytes verus*)

MELANIE BÄUCHLE

Department of Biomaterials, NYU, Paleoanthropology and Messel Research, Senckenberg Research Institute

Traditionally, dentition is used to compare similarities and discrepancies between extant primates and fossil hominids. The most commonly used dental feature is "tooth size", yet it is important to point out that "tooth size" refers almost exclusively to crown size. Crowns, however, are subjected to individual alteration from differing abrasions, and subsequently the crown surface (size, shape) is heavily altered, making comparison difficult. Roots in contrast, are protected in the alveolar bone and therefore much less affected by masticatory or even taphonomic processes. This study uses  $\mu\text{CT}$  to intensively investigate extant hominid mandibular molar metrics and their value in discriminating sex, taxa and populations.

Results show that molar root size and sexual dimorphism among great apes is highly complex and can be significant. Whether genus or populations differ, or sexual dimorphism is present in molar roots, depends on the molar and specific measurement, as well as genus and population affiliation. Overall, *Gorilla* have larger molars than *Pongo* and *Pan*; and Liberian chimpanzees have larger molars than Tai chimpanzees. The overall molar size order is  $M2 > M1 > M3$ . Interspecifically, *Pongo* has the most sexually dimorphic molars, followed by *Pan* and *Gorilla*.

This study demonstrates that an assumption regarding sex or species differences based on single molar (root) measurements can be wrong. It also shows that molar root sizes can vary significantly between populations of one subspecies (*Pan troglodytes verus*), which challenges the concept of tooth size as tool to differentiate between (fossil) hominid species.

The study has partially been funded through a Max-Planck-PhD-Stipend.

### Metric Sex Estimation using the Sustentaculum Tali

CHRISTINE A. BAILEY<sup>1</sup>, KRISTEN A. BROEHL<sup>2</sup>, ANIELLE C. DUNCAN<sup>1</sup>, AMY Z. MUNDORFF<sup>1</sup> and RENEE KOSALKA<sup>3</sup>

<sup>1</sup>Anthropology, University of Tennessee, Knoxville,

<sup>2</sup>Anthropology, California State University, Chico,

<sup>3</sup>Anthropology, Laboratoire de Sciences Judiciaires et de Médecine Légale, Québec

Sex estimation is a critical component for developing a biological profile for unknown skeletal remains because it reduces the number of potential matches by half. Non-traditional methods for estimating sex can be valuable when conventional methods are limited by fragmentation or missing elements. The calcaneus is a skeletal element that is often recovered intact, due to its robustness and protection within shoes. Previous research has also shown the calcaneus to be a sexually dimorphic bone. While these studies have included sexually dimorphic measurements of the calcaneus that encompass the sustentaculum tali (ST), none focus specifically on the dimensions of the ST. Therefore, this study aims to use measurements developed for the ST to discriminate male and female calcanei. Four measurements were taken from 150 calcanei (75 males, 75 females) from the William M. Bass Donated Skeletal Collection at the University of Tennessee, Knoxville. These measurements include maximum calcaneal length, load arm width, and two novel measurements, ST length and medial talar facet length. T-tests were conducted to assess intra and inter-observer error. The maximum calcaneal length measurement was not included in the analysis due to inconsistent measuring. Discriminant function analyses were conducted in SPSS 23. An additional sample of 40 calcanei was used test the functions. Including all three measurements, 82% of the original sample and 81% of the test sample was classified correctly, and including the two new measurements, 69.3% of the original sample and 78.6% was classified correctly. These new measurements can be beneficial for classifying fragmented calcanei.

### Sexual dimorphism of lumbar lordosis: a case for joint laxity

JEANNIE F. BAILEY<sup>1</sup>, ELLA BEEN<sup>2,3</sup> and PATRICIA A. KRAMER<sup>4</sup>

<sup>1</sup>Orthopaedic Surgery, University of California, San Francisco, <sup>2</sup>Physical Therapy, Ono Academic College, Israel, <sup>3</sup>Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University, Israel, <sup>4</sup>Anthropology, University of Washington, Seattle

From an evolutionary medicine perspective, sexual dimorphism of the lumbar spine may be linked to sex-specific orthopaedic issues. However, why lumbar lordosis differs by sex remains uncertain. One hypothesis posits that lordosis is positively selected to be greater in

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females to aid in lumbar extension while bearing a pregnancy load. An alternative explanation hypothesizes that higher lordosis in females is a pleiotropic effect of the increased joint laxity associated with childbirth. Increased joint laxity, which can create joint instability, is positively associated with lumbar lordosis, but has not been demonstrated to be sexually dimorphic. We explored potential sex differences in lumbar joint laxity by comparing intervertebral range of motion and segmental instability between females and males.

We conducted a retrospective analysis of rotation and translation of lumbar intervertebral segments from 350 females and 350 males without spinal trauma or previous surgeries (ages 19-90 years). Sex differences for sagittal rotation were dependent on age and in the older half of our study population lumbar flexion was 11.8% less in females than males ( $p=0.002$ ) and lumbar extension was 6.8% greater in females ( $p=0.02$ ). These sagittal rotation results correspond to higher lumbar lordosis in females. Furthermore, only females, regardless of age, had translational instability (spondylolisthesis) in the lower lumbar spine (L4-L5 and L5-S1).

Our results support that compared to that of males, range of motion in the female lumbar spine is associated with both greater lumbar lordosis and a heightened risk lumbar instability, which suggested that sex differences in joint laxity exist.

### The Relationship of the Glenoid Fossa and Acromion process as a Predictor of Locomotor Behavior

KATIE E. BAILEY<sup>1</sup> and NANDA B. GROW<sup>2</sup>

<sup>1</sup>Anthropology, Texas A&M University, <sup>2</sup>Sociology, Social Work, and Anthropology, Utah State University

The functional relationship between the scapula and locomotion is well documented in primates. For example, a more cranially oriented glenoid fossa is attributed to suspensory behaviors. The relationship between the acromion process and glenoid fossa is relatively nebulous. Here we test if the straight-line distance from the distal most point of the acromion process to the central most point of the glenoid fossa can be used as an indicator for locomotor behavior. The initial sample for this study includes scapulae from primates typically categorized in the literature as brachiators ( $n=18$ ) (*Hylobates spp.*, *Nomascus spp.*), quadrupeds ( $n=48$ ) (*Ptilocolobus spp.*, *Trachypithecus spp.*, *Cercopithecus spp.*), and semibrachiators ( $n=35$ ) (*Pygathrix spp.*). We predict brachiators will have an acromion process that projects the furthest past the glenoid fossa given how the acromioclavicular joint is often more robust for weight transfer between the glenohumeral joint, clavicle, and manubrium, and given how the clavicle is often elongated

in brachiators because of their increased overhead arm use, followed by semibrachiators, then quadrupeds. Preliminary results show there is a significant effect of locomotor category on acromion process length ( $F_{1,2} = 59.174$ ,  $p < 0.001$ ). The distances are significantly different between locomotor categories (Tukey's HSD: brachiator, quadruped  $p < 0.01$ ; semibrachiator, brachiator  $p = 0.014$ ; semibrachiator, quadruped  $p < 0.01$ ) with brachiators having the longest acromion process projection, followed by semibrachiators, and then quadrupeds. This information is particularly applicable to incomplete fossils where large quantities of the scapula might be missing.

Texas A&M Anthropology Department, Columbus Zoo and Aquarium Conservation Fund.

### Utility of deciduous lower first molar crown outlines in diagnosing *Homo sapiens* and *Homo neanderthalensis*

SHARA E. BAILEY<sup>1,3</sup>, STEFANO BENAZZI<sup>2</sup> and JEAN-JACQUES HUBLIN<sup>3</sup>

<sup>1</sup>Center for the Study of Human Origins, New York University, <sup>2</sup>Department of Cultural Heritage, University of Bologna, <sup>3</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Recent studies have demonstrated the utility of the outline shapes of deciduous upper and lower second molars and the deciduous upper first molar for diagnosing taxa – especially *Homo neanderthalensis* and *H. sapiens*. Building on these, here we assess the taxonomic significance of the crown outline of the deciduous lower first molar ( $dm_1$ ) through principal components analysis and quadratic discriminant analysis. We test whether the crown shape of the  $dm_1$  separates *H. neanderthalensis* from *H. sapiens*, and explore whether it can be used to correctly assign individuals to taxa. Our recent human sample includes 103 individuals from Africa, Europe, South America, India, and Australia. Our comparative sample includes 3 early *H. sapiens*, 8 Upper Paleolithic *H. sapiens* and 13 *H. neanderthalensis* individuals. Our results indicate that *H. neanderthalensis*  $dm_1$ s cluster fairly tightly and separate well from those of Upper Paleolithic *H. sapiens*. However, the range of shapes in the recent human sample overlaps ranges of all fossil samples. Consequently, results of the quadratic discriminant analysis based on the first five PCs representing more than 90% of the variation were mixed. Lower  $dm_1$ s were correctly classified in only 77.2% of the individuals: *H. sapiens* had better success (78.1%) than *H. neanderthalensis* (69.2%). When the analysis was re-run without recent humans (for whom variation was extensive) accuracy improved: 92.3% of *H. neanderthalensis* and 87.5% of Upper Paleolithic *H. sapiens* were classified correctly. We conclude that crown shape of  $dm_1$  is useful for identifying *H. neanderthalensis* and *H. sapiens* during the late Pleistocene.

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### Foreign Exchange in the Fourth Cataract Region of Ancient Nubia

BRENDA J. BAKER

Center for Bioarchaeological Research, School of Human Evolution & Social Change, Arizona State University

Recent work by the Bioarchaeology of Nubia Expedition (BONE) in the area upstream of the Fourth Cataract in northern Sudan enriches our understanding of the extent of isolation or integration of people peripheral to the main centers where state-level societies operated. Variability in grave architecture and burial treatment at inter-visible cemetery sites from the Kerma period (c. 2500-1500 BC) is evident within and between sites. Differences in burial style and accompaniments may relate to differing expressions of identity. Exotic material includes shell beads from Red Sea molluscs, carnelian beads, Egyptian ceramic vessels, and other as yet unidentified ceramics. The latter appear in an outlier grave of a potential potter at Site ASU 09-01. One grave at ASU 14-04 seems to amalgamate local and Egyptianized styles. The usual circular or oval, rock-capped superstructure covers an ovoid burial shaft around 50-80 cm deep with a tightly flexed individual positioned on the right or left side in variable orientations. In the Egyptianized instance, the normative superstructure covered a shallow, trench-like shaft in which the body was placed in an extended, supine position in an east-west axis. Later Meroitic (c. 350 BC-AD 350) through Post-Meroitic (c. AD 350-550) period mortuary remains in the floodplain nearby also include a few burials with extra-local items, suggesting continuing access to exchange networks in the region despite the construction of forts and evidence of conflict at this time. An agropastoral lifestyle—not just exchange along the Nile River—may help explain these interconnections.

Qatar-Sudan Archaeological Project, A-17.

### Using Bacterial Communities From Human Femora To Determine Post Mortem Interval

STEPHANIE A. BAKER, SARAI N. MESA and MARY N. RUBLE

Biology, Sam Houston State University

Current techniques of estimating postmortem interval (PMI) are based on changes in cadaver decomposition, insect activity and bacteria succession. These methods are subject to various abiotic and biotic factors, such as temperature and humidity. Additionally, soft tissue methods are only useful days to weeks post mortem. Bacteria inside marrow-containing bones, however, are protected from many external variables and persist in the environment for months. This project studies the makeup and succession of bacteria inside the human femur.

## ABSTRACTS

We sampled bone marrow inside the femora of three cadavers (two male and one female) placed at the Southeast Texas Applied Forensic Science (STAFS) facility in Huntsville, Texas for four months. The left femurs were sampled every other day and the right femurs were sampled every fifth time as a control for introduced contamination. We used a sterilized drill to make a hole in the diaphysis of the femur. A sterilized T-Lok medical grade biopsy needle was then inserted to collect bone marrow, which was then placed into a cryotube. Holes were sealed to prevent contamination. Samples were shipped to Baylor College of Medicine and analyzed using deep sequencing of 16SrRNA gene, which is unique to bacteria. Microbial communities were analyzed using UniFrac to identify relationships between microbial communities in each cadaver. Preliminary results indicate the bacterial communities in the femur change consistently and predictably. As such, the femur may offer a more accurate and persistent method for estimating PMI.

### History of Human Population Diversity Studies in Central America

NORBERTO F. BALDI<sup>1</sup> and RAMIRO BARRANTES<sup>2</sup>  
<sup>1</sup>Anthropology, University of Costa Rica, <sup>2</sup>Biology, University of Costa Rica

Central America has been the site of continuous scientific studies of human population structure and diversity since the beginning of the 20<sup>th</sup> century, yet the history of these investigations has never been formally catalogued. In order to evaluate scholarly contributions to the development of human population genetics in Central America we summarize, classify, and compare 145 references contained in 117 scientific publications since 1920s until 2015. The development of human population genetics in Central America builds on studies elaborated from the 1920s to the 1960s of morphological and biochemical variation of local indigenous populations. Between the 1970s and the 1990s, new serological discoveries made microevolutionary studies possible among indigenous and afro-Caribbean populations. Molecular genetics investigations initiated in the 1990s in Central America ushered in a new era for the examination of 21<sup>st</sup> century evolutionary questions. During this period, the use of a wide variety of informative markers enabled the unraveling of demographic histories of national and indigenous populations. Despite the steady development of population genetics in Central America, differences exist in the quantity and quality of investigations in the area: Costa Rica (35%), Nicaragua (17%) and Panama (16.5%) are the most frequently studied countries in comparison with Guatemala (12.5%), Honduras (9%), El Salvador (6%), and Belize (4%). Through tracing the development of molecular genetics investigations in the region, the authors hope to focus

future research towards areas of need in order to ensure the development of the most complete profile possible of human population genetics in Central America.

### Osteometric Reconstruction of Body Mass in the Lambayeque Valley Complex, Peru: Pre-Hispanic Variability and the Impact of Spanish Conquest

STEVEN J. BALL<sup>1</sup> and HAAGEN D. KLAUS<sup>1,2</sup>

<sup>1</sup>Department of Sociology and Anthropology, George Mason University, <sup>2</sup>Museo Nacional Sicán, Peru

Body mass represents one of the least studied and understood reflections of biocultural relationships in ancient South America. Here, we present the results of the first diachronic, regional, and osteometric reconstruction of body mass variability in the Central Andes. In a region where previous studies demonstrated that terminal adult stature was highly developmentally canalized, we test the hypothesis that body mass was similarly invariant during in late pre-Hispanic and postcontact northern Peru. Maximum anterior-posterior femoral head diameter measurements were collected from the skeletal remains of 304 indigenous individuals spanning 2600 B.C.- A.D. 1750 in the Lambayeque Valley Complex (pre-Hispanic sites of Ventarrón, Arenal, Collud, and Zarpán [n=74]); postcontact sites of Eten [n=73] and Mórrope [n=157]). Body mass was estimated for males, females, and individuals of indeterminate skeletal sex using previously established standard equations. Results demonstrate unexpected variations of predicted body weight within and between pre-Hispanic sites. Also, following European conquest, average body mass values show a 7 % increase in Colonial Eten (4.0 kg) and a 5.4 % increase in Colonial Mórrope (3 kg) contained within a narrow range of variation. We reject the hypothesis. Body mass, unlike stature, appears to demonstrate a greater degree of biocultural and environmental plasticity than other previously studied components of body size. Further, the mild increase in body mass associated with the postcontact adaptive transition in Lambayeque may relate to widespread increased reliance on carbohydrates in Colonial-era native diets that is further concordant with bioarchaeological findings and ethnohistoric accounts from northern Peru.

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### Are marital system, climate and geographic origin good predictors of human craniofacial size and shape variation?

KATHARINE BALOLIA<sup>1</sup> and CHRISTOPHE SOLIGO<sup>2</sup>

<sup>1</sup>School of Archaeology and Anthropology, The Australian National University, <sup>2</sup>Department of Anthropology, University College London

The majority of research investigating modern human craniofacial size and shape variation to date has focused on variables associated with climate, geographic origin and genetic drift, and few attempts have been made to understand whether variation in modern human craniofacial morphology is associated with aspects of social behaviour. Using a sample of 9 modern human populations (314 males and 260 females), we test the hypothesis that modern human facial and neurocranial size and shape variation is associated with marital system. Using 3D landmark data taken from cranial 3D surface scans, we assess the relative contributions of sex, climatic variables and geographic origin on craniofacial size and shape variation. We find significant sex differences in facial size allometry in monogamous populations that are not observed in polygynous populations. After controlling for climatic variables, marital system explains a small amount of facial size variation (2.4% in males and 5% in females) but we find no significant association between marital system and facial shape variation. Although marital system only explains a small amount of craniofacial size variation, the finding that sex-specific patterns of facial allometry differs between populations adopting a monogamous and polygynous marital system warrants further study. Our findings provide a basis to further investigate whether craniofacial morphology evolves in response to variables associated with social behaviour in modern humans.

### Upper Paleolithic and recent human brain variation and evolution

ANTOINE BALZEAU, DOMINIQUE GRIMAUD-HERVÉ and LOU ALBESSARD

Prehistory, CNRS, UMR 7194, Département de Préhistoire du Muséum national d'Histoire naturelle, UPMC, UPVD, Paris, France.

The evolution of the hominin brain is well documented from studies of endocranial casts, or endocasts. However, and although the size and morphology of the brain are considered one of the most characteristic traits of *Homo sapiens*, variations in cerebral form, size and shape since the emergence of our species are poorly documented.

The aim of this study was to compare fossil and extant AMH endocasts in order to start filling this gap in the literature. Our comparative samples consist in a geographically diverse selection of extant AMH and of Upper Palaeolithic *Homo sapiens* from the sites of Skhul, Qafzeh, Brno, Cioclovina, Cro-Magnon, Mladeč, Pataud, Peñtara Muierii and Predmostí. Metric measures were acquired with callipers and cephalometers on the endocasts or on drawings for projected measures. 3D landmarks for geometric morphometric analyses were also digitized.

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A decrease in absolute endocranial volume since the Upper Palaeolithic was noticeable. Although extant and older endocrania share the same anatomical layout, we found non-allometric differences in the relative size and organization of different parts of the brain. Our results suggest a gradual change from the Upper Palaeolithic average morphology to those of extant populations and document previously unknown intraspecific anatomical variations in the *H. sapiens* brain, demonstrating its plasticity, with some areas (frontal and occipital lobes) having been more subject to variation than others (parietal, temporal or cerebellar lobes). That may be due to constraints to maintain an optimal performance while reducing in size and changing in shape during our recent evolution.

### Violence in 18<sup>th</sup> and 19<sup>th</sup> Century London: Analyzing Trauma Prevalence by Cemetery, Age, and Sex

PETRA BANKS and D. SHANE MILLER

Department of Anthropology and Middle Eastern Cultures, Mississippi State University

Socioeconomic disparity and crime are sometimes associated with increases in violence against lower-social status individuals, such as women, children, and the poor, particularly in highly stratified societies. 18<sup>th</sup> and 19<sup>th</sup> Century London was highly stratified, and characterized by insalubrious living conditions for the poor with high urban mortality and morbidity. Here, I investigate whether contemporary skeletal samples demonstrate demographic patterns of potential interpersonal violence. I analyzed three post-medieval assemblages, of different socioeconomic strata: the higher status Chelsea Old Church cemetery (n=784), and the lower socioeconomic status St. Brides Lower (n=1926) and Cross Bones cemeteries (n=690). Data for skeletons of all age ranges and sexes were derived from the Wellcome Osteological Research Database at the Museum of London Centre for Human Bioarchaeology. I investigated correlations between trauma, specifically lesions typically associated with interpersonal violence, and age, sex, and socioeconomic status at the level of the cemetery. Results indicate there is no significant correlation between rates of traumatic lesions typically associated with interpersonal violence, sex, age, and cemetery-level socioeconomic status. Although there were socioeconomic disparities between the original contemporary communities associated with these cemeteries, the skeletal samples do not yield any evidence of disparities in exposure to interpersonal violence between them, though this conclusion must be tempered by overall low frequencies of interpersonal trauma across all of the assemblages (less than 1%), and the relative rarity with which interpersonal violence may affect the skeleton in an archaeologically visible way.

### Which tree animal types live in areas together, and why? In part because of people things

KATHERINE H. BANNAR-MARTIN

Synthesis Centre (sDiv), German Centre for Integrative Biodiversity Research (iDiv)

Landscape modification, through urbanization, agriculture, mining or other forms of land use, can disrupt the connectivity of forests, with major consequences for arboreal biodiversity. In Madagascar, extensive landscape modification has created anthropogenic matrices between protected areas, affecting their connectedness and the ability of species to potentially disperse between them. The primate communities of Madagascar comprise an endemic and endangered group of arboreal mammals. Dispersal limitation by distance between protected areas has been previously shown to be a stronger explanation for the composition of Malagasy arboreal mammal communities than environmental sorting. However, the anthropogenic matrix between protected areas in Madagascar poses an additional potential dispersal barrier for arboreal species. In this study, I contrasted the relative contribution of environmental sorting, dispersal limitation by distance, and site isolation via the anthropogenic matrix (from a composite measure of human population density, land transformation, transportation routes, and power infrastructure) to the composition of primate communities in 34 of Madagascar's protected areas. Malagasy primate community composition was significantly and jointly explained by dispersal limitation by distance, environmental sorting, and the degree of isolation via the anthropogenic matrix. Protected areas were clustered and isolated by varying degrees of landscape modification, particularly in the northwest and southeast of Madagascar. This study provides evidence of the compounding effect of human land use modification and urbanization on the ecology and distribution of Malagasy primates.

### Postnatal Neuron increase in the Human Amygdala is more Extensive than in other Hominids

NICOLE BARGER<sup>1,2</sup>, MARTHA V. VARGAS<sup>2</sup>, THOMAS A. AVINO<sup>1,2</sup>, KATERINA SEMENDEFER<sup>3,4</sup> and CYNTHIA M. SCHUMANN<sup>1,2</sup>

<sup>1</sup>Psychiatry and Behavioral Sciences, University of California, Davis, <sup>2</sup>UC Davis MIND Institute, University of California, Davis, <sup>3</sup>Anthropology, University of California, San Diego, <sup>4</sup>Neuroscience Graduate Program, University of California, Davis

The amygdala mediates socioemotional processing, has been linked to social complexity, and is one of few brain structures reported to incorporate new neurons postnatally. Neuron numbers increase through macaque development, but only in the paralaminar region. The influence of this increase on whole amygdala

number is unknown. We hypothesize that neurons in the amygdala's basal and lateral nuclei, which incorporate the paralaminar in hominids, would be most likely to show age-related increase in hominids and that this might influence whole amygdala numbers.

To test this, we fit regression lines and curves to stereological estimates of neuron number in humans 2 to 48 years (n=22) and African apes 9 months to 50 years (n=13). To better parse this broad developmental span, we also ran the analyses on sample subsets, iteratively decreasing sample composition by 10 year increments. In humans, we found a significant linear relationship between neuron number and age in the amygdala and basal nucleus up to 32 years. In apes, a significant inverse model (high rate of early increase that plateaus over time) fit basal data through all but the youngest subset, peaking between 10 and 20 years. Lateral nucleus models were not significant.

We provide evidence for an age-related increase in neurons in the hominid basal nucleus. However, humans exhibited a longer period of age-related increase, into the third decade of life, also visible in the amygdala. We speculate that this protracted period of neuron increase supports the extended period of cultural and social learning characterizing our species.

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### Bovid locomotor traits track land cover and mean annual precipitation: using an ecometric approach to reconstruct paleoenvironments in the Shungura Formation (Plio-Pleistocene, Ethiopia)

W. ANDREW BARR

Center for the Advanced Study of Human Paleobiology, The George Washington University

Reconstructing hominin habitats across space and time is a major goal of paleoecology. Studies of bovid (antelope and relatives) locomotor ecomorphology have used morphological traits to infer habitat-specific locomotor adaptations for fossil specimens. However, linking ecomorphic data with quantitative characteristics of hominin habitats has proved challenging. This study introduces a new approach using bovid locomotor traits as "ecometric" variables for estimating mean annual precipitation (MAP) and land cover.

I compiled five traits of the astragalus and five traits of the metatarsal for bovid species occurring at gridded locations (50 km x 50 km) across sub-Saharan Africa and obtained MAP and land cover estimates for the corresponding locations.

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I used a General Linear Model (GLM) to quantify the relationship between MAP, land cover, and the average trait values for all species occurring at each location. Next, I measured astragalus ecometric traits on 216 fossil astragali from the Shungura Formation (covering the period 3.4 – 1.9 Ma). I applied the GLM to infer MAP for each Shungura geological member using the trait averages for all specimens in each member.

Results on modern data demonstrate that several astragalus and metatarsal ecometric traits explain major proportions of variation in MAP and land cover ( $R^2 > 0.6$ ). In the Shungura Formation, results are consistent with habitats with MAP values ranging from ca. 700 mm to nearly 1600 mm. Although challenges remain in directly comparing the modern and fossil datasets, the ecometric method offers a promising way to quantitatively characterize hominin habitats.

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### Water Soluble Nutrient Intake and Leptin Phenotypes in the Kansas Mennonite

CHRISTOPHER E. BARRETT<sup>1</sup>, MICHAEL CRAWFORD<sup>2</sup> and M.J. MOSHER<sup>3</sup>

<sup>1</sup>Anthropology, University of Kansas, <sup>2</sup>Anthropology, University of Kansas, <sup>3</sup>Anthropology, Western Washington University

Diseases of Western Civilization and metabolic dysfunctions have spread globally with alarming speed and prevalence. Causes are a racemic mix of environmental, biological, nutritional and behavioral factors which vary between populations and sex. Nutrients and their cellular receptors work in concert to modify genetic activity using nutrigenetic pathways. These gene-nutrient interactions are known to ameliorate certain risk factors including aberrant levels of hormones such as leptin. Adipose derived hormones, or 'adipokines', such as leptin regulate many homeostatic processes with novel utility in treating chronic and metabolic conditions. Research in human and non-human models suggests possible connections between select lipid or water soluble micronutrients and metabolic biomarkers. However, these reports are too often exclusively reductionist, use obsolete methodologies or hyper focus on a single nutrient explanations.

We test the relationships between micronutrient intake and variation in leptin phenotypes using sex-specific and multi-nutrient models, examining the associations with measures of disease risk including adiposity, blood lipids and adipokine concentrations in a population of Kansas Mennonite (N=160) with histories of fission and fusion. Multivariate regressions were run sex-specifically (females=84; males=76) and were controlled for adipose tissue. Intake

of water soluble vitamin B<sub>6</sub> was significant for leptin phenotypes in women ( $\beta=0.324, p=0.043$ ). Vitamin B<sub>6</sub> is needed for neurotransmitter synthesis and regulating the bodily clock and epigenetic methylation. Results suggest associations between nutritional intake and metabolic biomarkers may be nutrient and sex-specific.

### Stable Isotope Evidence for Salmon Consumption in the Prehistoric Sacramento Valley of California

ERIC J. BARTELINK<sup>1</sup>, JAMES NELSON<sup>2</sup>, DENISE FURLONG<sup>3</sup>, STEFANIE KLINE<sup>4</sup>, JULIA PRINCE-BUITENHUY<sup>5</sup>, AMY MACKINNON<sup>6</sup> and FRANK BAYHAM<sup>1</sup>

<sup>1</sup>Department of Anthropology, California State University, Chico, <sup>2</sup>Cultural Resources Division, Pacific Gas & Electric, <sup>3</sup>Archaeology Division, Furlong & Associates, <sup>4</sup>Cultural Rescue Initiative, Smithsonian, <sup>5</sup>Department of Anthropology, Notre Dame, <sup>6</sup>Archaeology Division, Parsons Brinckerhoff

Evidence for the prehistoric consumption of salmon in the Sacramento Valley is based primarily upon the ethnographic record and ethnohistoric accounts. These lines of evidence, in conjunction with the known seasonal spawning runs of salmon documented during the historic period, suggest that salmon were a highly valued food resource throughout the Sacramento River watershed. However, zooarchaeological studies have found that salmon bones comprise a relatively small portion of fish bone assemblages in the southern Sacramento Valley region. To estimate the dietary importance of salmon along the northern and southern ends of the Sacramento Valley, stable carbon and nitrogen isotopes of bone collagen are examined from human burials from six late Holocene (4500–200 B.P.) central and northern California sites.

Individuals from the southern Sacramento Valley show low  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values, regardless of time period, and very little dietary variation. These values are most consistent with a dietary focus on freshwater fish with small contributions from salmon. However, individuals from the northern Sacramento Valley show notably high  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values, clearly indicating a larger contribution of salmon to the diet. Together, these data indicate strong evidence for salmon consumption in the northern Sacramento Valley, but not in the southern Sacramento Valley. These data corroborate patterns observed in late Holocene zooarchaeological assemblages, but contradict ethnographic and ethnohistoric accounts regarding the importance of salmon in the southern Sacramento Valley.

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### Guided by voices: using social media to target small ape surveys in Peninsular Malaysia

THAD Q. BARTLETT<sup>1</sup>, SUSAN LAPPAN<sup>2</sup> and NADINE RUPPERT<sup>3</sup>

<sup>1</sup>Anthropology, The University of Texas at San Antonio, <sup>2</sup>Anthropology, Appalachian State University, <sup>3</sup>School of Biological Sciences, Universiti Sains Malaysia

Citizen science communicated by social media has the potential to play an important role in primate conservation and assessment, particularly for populations that have not been surveyed recently. In preparation for a survey of small apes (Hylobatidae) in the Malay Peninsula we reviewed common social media outlets (e.g., YouTube, SoundCloud, and hosted blogs) for recent records of three hylobatid species (*Hylobates lar*, *H. agilis*, and *Symphalangus syndactylus*) throughout the peninsula. We deemed a record reliable if it included a date of observation, location information, and an audio recording, photograph, or video. Using these online records, we identified 23 sites outside of protected state and national parks with recent records indicating the presence of small apes. A preliminary ground survey during August 2016 confirmed the presence of the species indicated at 3 of these sites—Bukit Fraser (*H. lar* and *S. syndactylus*), Bukit Larut (*H. agilis*), and Genting Highlands (*S. syndactylus*). Hylobatids were not observed at two other sites (Cameron Highlands and Bukit Tinggi) where records indicated their presence as recently at 2010. We relied on auditory methods to document the occurrence of small apes, so it is possible that animals were present but not detected, since hylobatids do not call every day. Nonetheless, these results suggest that social media records of primates may help to identify sites and habitats under high threat or where extinction has occurred very recently. One issue that must be resolved is how to aggregate social media records without providing detailed information to potential poachers.

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### Geometric morphometrics of hominoid thoraces and its bearing for reconstructing the ribcage of *H. naledi*

MARKUS BASTIR<sup>1,2</sup>, DANIEL GARCÍA-MARTÍNEZ<sup>1,2</sup>, SCOTT A. WILLIAMS<sup>3,4</sup>, MARC R. MEYER<sup>5</sup>, SHAHED NALLA<sup>2,6</sup>, PETER SCHMID<sup>2,7</sup>, ALON BARASH<sup>8</sup>, MOTOHARU OISHI<sup>9</sup>, NAOMICHI OGIHARA<sup>10</sup>, STEVEN E. CHURCHILL<sup>11,2</sup>, JOHN HAWKS<sup>12,2</sup> and LEE R. BERGER<sup>2</sup>

<sup>1</sup>Department of Paleobiology, Museo Nacional de Ciencias Naturales CSIC, <sup>2</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand, <sup>3</sup>Center for the Study of Human Origins, Department of Anthropology, New York University, <sup>4</sup>New York Consortium in Evolutionary Primatology, <sup>5</sup>Department of Anthropology, Chaffey College, <sup>6</sup>Department

## ABSTRACTS

of Human Anatomy and Physiology, Faculty of Health Sciences, University of Johannesburg, <sup>7</sup>Anthropological Institute and Museum, University of Zurich, <sup>8</sup>Faculty of Medicine Galilee, Bar Ilan University, <sup>9</sup>Laboratory of Anatomy 1, School of Veterinary Medicine, Azabu University, <sup>10</sup>Department of Mechanical Engineering, Faculty of Science and Technology, Keio University, <sup>11</sup>Department of Evolutionary Anthropology, Duke University, <sup>12</sup>Department of Anthropology, University of Wisconsin-Madison

*H. naledi* shows a mosaic morphological pattern with several derived (*Homo*-like) features of the skull, hands and feet, and primitive (australopithec-like) features in the ribcage, shoulder, and pelvis. This pattern reflects a morphology that might be expected of a hominin at the evolutionary transition between *Australopithecus* and *Homo*. Two thoracic vertebrae from levels 10 and 11 and the proximal aspect of an 11th rib were found in near anatomical connection in the Dinaledi Chamber of Rising Star cave, therefore likely belonging to the same individual. In this study we explore this association and report our ongoing work towards a quantitative 3D reconstruction of the *H. naledi* thorax. We measured 512 3D-(semi)landmarks on human and other hominoid ribcages (hylobatids, *Pongo*, *Gorilla*, *Pan*; N=33) for geometric morphometric analyses. Covariation between the 11th rib and remaining thorax shape was analyzed by partial least squares analysis (PLS) and overall thorax variation by principal components analysis (PCA). PCA results show wide ranges of complex thoracic variation. *Gorilla* and *Pan* are characterized by highly constricted upper thoraces when compared to their wide lower ribcages. *Pongo* and hylobatids have less narrow upper but also wide lower thoraces. Those of humans are expanded superiorly, narrow inferiorly, and with declined ribs. PLS analyses suggest that the morphology of the articulated rib-vertebra complex at the 11th level of *H. naledi* is compatible with a ribcage with declined ribs and inferiorly wider than observed in humans. This corresponds with evidence for laterally flared iliac blades of the *H. naledi* pelvis.

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### Isotopic analysis of pre-Columbian Groups from the Brazilian coast

MURILLO Q. R. BASTOS<sup>1</sup>, ANDREA LESSA<sup>1</sup>, ROBERTO V. SANTOS<sup>2</sup> and CLAUDIA RODRIGUES-CARVALHO<sup>1</sup>

<sup>1</sup>Anthropology, Museu Nacional, Universidade Federal do Rio de Janeiro, <sup>2</sup>Geosciences, Universidade de Brasília

Carbon, nitrogen and strontium isotope analysis have been carried out on skeletal remains excavated from shellmounds and other pre-Columbian sites found in the South and Southeastern coast of Brazil in order to revise old models and propose new hypothesis of these groups' diet, residential mobility and some other aspects of their

lives. Bone, dentin and enamel preparation were performed considering diagenetic, breastfeeding period and isobaric interferences.

In the case of Praia da Tapera and Forte Marechal Luz, coastal sites from Santa Catarina state that presented ceramics associated with inland groups, the isotopic analysis done on dental enamel and dentin pointed out that all individuals had a strong relation with the coast since their childhood, weakening the model that these sites were occupied by individuals from the plateau. The wider strontium variation found in women also suggests coastal migration and could be related to post-marital practices.

While archaeological and isotopic analysis indicate that shellmound builders groups had in general marine food as the most important protein source, individuals analyzed from the Zé Espinho Shellmound, in Rio de Janeiro, presented a very diversified diet, deconstructing the perspective that these groups had an homogenous nutrition.

New isotopic studies related to pre-Columbian coastal Brazilian populations are underway in order to enhance our comprehension about their economy, life style and trade between these groups. However, due to the economic crisis Brazil is facing for the past few years, the budget for archaeological studies is being reduced, compromising the progress of our research.

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### Agent-Based Modeling of Geographic Barriers and Gene Flow in Fuego-Patagonia

VINCENT M. BATTISTA

Anthropology, University of Michigan

The first people to set foot in Southern Patagonia (Chile and Argentina) navigated mountainous terrain dominated by ice fields and glaciers. The distribution of rare mtDNA haplogroups and distinct craniometric traits found in Fuego-Patagonia are possibly the result of this complex topography and isolation by distance. Presented is an agent-based model that investigates the hypothesis that geographic barriers led to marked genetic drift and a strong founder effect in southernmost Patagonia.

This model generates a population of agents randomly distributed atop an interactive map of Late Pleistocene Patagonia; these "hunters" can disperse in random headings and can opportunistically admix with any other agents they encounter. Preliminary results suggest that barriers such as the Andes, glacial fields, and the Straits of Magellan alone could not prevent large amounts of geneflow from either entering or leaving Fuego-Patagonia. However, recursive

catastrophic events (e.g., volcanic eruptions, marine incursions) on small, structured groups minimized gene flow between mainland and island populations. Given that this model does not control for variation in climate, it is possible that environmental factors or merely a lack of adaptive mechanisms (e.g., to cold climate) also played a role in preventing population expansions into or away from Fuego-Patagonia. Overall, this exploratory and simplistic model suggests that static geographic barriers alone cannot account for genetic isolation in this topographically complex region.

### Dental developmental patterns and tooth internal structure in European Upper Paleolithic humans

PRISCILLA BAYLE<sup>1</sup> and MONA LE LUYER<sup>1,2</sup>

<sup>1</sup>UMR5199 PACEA, University of Bordeaux, <sup>2</sup>School of Anthropology and Conservation, University of Kent

While differences have been reported between Neandertals and extant humans in their patterns of dental development and internal tooth structure, few studies have focused on the evaluation of these parameters in Upper Paleolithic humans. Above all, dental maturational patterns and metamer variation in tissue proportions along the arcade, and how these processes are linked together, have not been quantified through the Upper Paleolithic. Here we used microCT-based data, as well as radiographic and CT records, to finely quantify these variables in the deciduous and permanent dentitions of the Gravettian child from Lagar Velho, in Portugal, the Middle Magdalenian individual Lafaye 25 from Bruniquel, and the Epipaleolithic child from La Madeleine, both in France, and compare the measures between themselves and to the Neandertals, historical and extant humans of worldwide origins. While the Gravettian child shows a discrepancy in its incisor relative to molar development compared to extant children, the Magdalenian and Epipaleolithic individuals fit this comparative sample and differ from the Neandertal pattern. This is complemented by differences in tissue proportions between Lagar Velho and the two more recent individuals, the first having particularly large incisor dentine volumes and high metamer variation. Although future investigations are needed to unlock the genetically- and/or functionally-related factors sustaining these observations, our results suggest that the dental developmental and structural variation, still far from being documented, may bring significant contribution to the recent reappraisal of the human paleobiological and phylogenetic history throughout the European Upper Paleolithic.

# ABSTRACTS

## Physiology, fertility, and population genetics

CYNTHIA M. BEALL<sup>1</sup> and ANNA DI RIENZO<sup>2</sup>

<sup>1</sup>Anthropology, Case Western Reserve University,  
<sup>2</sup>Human Genetics, University of Chicago

Adaptations resulting from natural selection can be difficult to detect because biological characteristics reflect both heritable and non-heritable factors. This study accounted for social, economic, and public health influences while testing the hypothesis that relatively low hemoglobin concentration associated with reproductive success in a sample of 1,006 post-reproductive Tibetan women residing at altitudes from 3000-4100m in Nepal.

We collected reproductive histories by interviews in native dialects and DNA from saliva samples. Poisson and binomial regression analyses selected influential covariates of the number of pregnancies, livebirths, and children surviving to 15. We conducted genome-wide association studies using 3.5 million single-nucleotide polymorphism sites.

Apart from physiological phenotype, the largest reproductive disadvantages accrued to women who never married or had a late first birth. The largest reproductive advantages accrued to women residing in one of four sub-districts or had a late last birth. Taking such factors into account, higher hemoglobin concentration associated with poorer reproductive success measured as the probability a pregnancy progressed to a live-birth. We detected a genome-wide significant association of *EPAS1* variants with oxygenated hemoglobin concentration, consistent with previous reports, but these variants did not associate with pregnancy outcome.

The findings illustrate the complexity of identifying adaptations. They support the hypothesis that selection is acting against elevated hemoglobin concentration or another correlated trait among Tibetans at high altitude.

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## Dispersal of early haplorhine primates by rafting across Tethys: Discovery of an Eocene omomyid from northern Anatolia

K. CHRISTOPHER BEARD<sup>1,2</sup>, GRÉGOIRE MÉTAIS<sup>1,2,3</sup>, ALEXIS LICHT<sup>4</sup>, PAULINE COSTER<sup>1,2</sup>, FARUK OCAKOĞLU<sup>5</sup>, JOHN KAPPELMAN<sup>6</sup> and MICHAEL H. TAYLOR<sup>7</sup>

<sup>1</sup>Biodiversity Institute, University of Kansas,  
<sup>2</sup>Department of Ecology & Evolutionary Biology, University of Kansas, <sup>3</sup>Département Histoire de la Terre, Muséum national d'Histoire Naturelle,  
<sup>4</sup>Department of Earth and Space Sciences, University of Washington, <sup>5</sup>Department of Geological Engineering, Eskişehir Osmangazi University,  
<sup>6</sup>Department of Anthropology, University of Texas,  
<sup>7</sup>Department of Geology, University of Kansas

The first Paleogene primate from Turkey has been recovered from the middle Eocene Lülük Member of the Uzunçarşidere Formation (UCF) in the Orhaniye Basin. Geochronological constraints, based on U-Pb dating of detrital zircons and paleomagnetic reversal stratigraphy, indicate an age of 43-44 Ma for the mammalian fauna containing the new Turkish primate. The UCF primate can be allocated to Omomyidae, but it clearly represents a new taxon on the basis of its unique combination of primitive and autapomorphic characters. The lower molar morphology of the UCF omomyid resembles that of omomyines such as *Ourayia* and *Mytonius*. However, p4 in the new taxon is remarkably long, a primitive character that resembles conditions in early adapiforms, while p4 is typically compacted mesiodistally in omomyids.

The UCF omomyid was part of a highly endemic mammalian fauna inhabiting this part of Anatolia during the middle Eocene. The UCF mammal fauna also includes marsupials, embrithopods, a primitive bat, and pleuraspidotheriid "condylarths". The endemic and unbalanced character of the UCF mammal fauna indicates a long interval of isolation from adjacent parts of Eurasia, suggesting that northern Anatolia was an island in the Tethys Sea at this time. Based on the absence of such characteristic late Paleocene/early Eocene clades as rodents, artiodactyls and perissodactyls in the UCF fauna, the UCF omomyid probably dispersed to Anatolia by rafting across part of Tethys. The UCF omomyid antedates the oldest African anthropoids by several Ma, highlighting how rafting across Tethys may explain the origin of the African anthropoid radiation.

Research supported by NSF grants BCS-1441585 and EAR-1543684.

## A Stable Oxygen Isotope Mosaic Index: Implications for Reconstructing Hominin Paleoenvironments in East Africa

MELANIE M. BEASLEY and MARGARET J. SCHOENINGER

Anthropology, University of California, San Diego

Paleoenvironmental reconstructions in east Africa often rely on surface-collected fossil fauna even though such collections traditionally combine multiple temporal and geographically dispersed components. Therefore the scale of analysis often generates an interpretation that early hominin environments were mosaic habitats. However, the term "mosaic" encompasses a variety of ecosystems varying from closed to open-canopy each of which will be differentially impacted by the relative wetness in an ecosystem. Among east African large mammals recovered from fossil localities, often Hippopotamidae have the lowest  $\delta^{18}\text{O}_{\text{en}}$  values and Giraffidae have the highest. Recently, a giraffe-hippo offset ( $\mu_{\text{gir-hip}}$ ),

which indicates the relative wetness of a fossil locality, has been used to refine interpretations of paleoenvironments. This project compares the giraffe-hippo offset from Aramis (~4.4 Ma), Allia Bay (~3.97 Ma), Hadar (3.8-3.24 Ma), Woranso-Mille (3.76-3.57 Ma), and modern Koobi Fora. Traditional interpretations of the giraffe-hippo offset conclude drier sites have larger offsets, while wetter sites have smaller offsets. However, our analysis of the fossil localities and the known Koobi Fora arid environment result in the Koobi Fora giraffe-hippo offset as the smallest value. We argue that the giraffe-hippo offset might not suggest the relative wetness of an environment, but rather be used as an indicator of habitat variability. We suggest that large offsets indicate greater variability between the hippo and giraffe ecological niches within an ecoregion. Therefore larger offsets would have a greater number of niches within an ecoregion indicating a more mosaic habitat compared to localities with small offsets.

## Y STR Variation in Six Garífuna Villages on the Honduran Coast

KRISTINE G. BEATY<sup>1</sup>, EDWIN-FRANCISCO HERRERA-PAZ<sup>2</sup>, NORBERTO BALDI-SALAS<sup>3</sup>, NICOLE BRACCI<sup>4</sup>, MIREYA MATAMOROS<sup>5</sup>, MICHAEL H. CRAWFORD<sup>1</sup> and REENA ROY<sup>4</sup>

<sup>1</sup>Laboratories of Biological Anthropology, University of Kansas, Lawrence, KS, USA, <sup>2</sup>Facultad de Medicina, Universidad Católica de Honduras, Campus San Pedro y San Pablo, San Pedro Sula, Honduras, <sup>3</sup>Escuela de Antropología, Universidad de Costa Rica, San Pedro, San José, Costa Rica, <sup>4</sup>Biochemistry and Molecular Biology, The Pennsylvania State University, 107 Whitmore Lab, University Park, PA, USA, <sup>5</sup>Dirección de Medicina Forense, Ministerio Público de Honduras, Tegucigalpa M.D.C., Honduras

The Garífuna are an Afro-Caribbean people, the product of escaped slaves intermarrying with native Arawak speakers on St. Vincent Island in the Caribbean. Britain took control of the island and, in 1796, the Garífuna lost control of their homeland to Britain. Some 2400 survivors were transported off the island to Roátan, an island off the northeastern coast of Honduras. Within months of deportation, Garífuna moved to the Honduran coast, establishing settlements in Trujillo. As the population rapidly expanded, settlements appeared throughout the Central American coast stretching from Belize to Nicaragua, settlements that are now home to some 300,000 Garífuna. This mode of settlement typically leaves marks of genetic drift that should be detected as distance from Trujillo increases. However, by the end of the 1800s, Garífuna men were consistently travelling throughout Central America for work. Today this migratory pattern is increasing in frequency. This study examines the effects of labor driven migration on Y-STR diversity in 6 Garífuna Villages on the Honduran coast (Cristales, Río Negro, Santa Fe, Iriona, Corozal

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and Bajamar). A total of 45 haplotypes were observed amongst participants. Thirty-two haplotypes were unique to their village, while the other 13 were commonly found in several villages, with an African haplotype found in 15 percent of participants from every village except Rio Negro. A relationship of genetic distances and geography was not seen ( $r=0.0473$ ,  $p=0.4496$ ). These results reveal marks of genetic drift overlaid with marks of male gene flow.

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### You win some, you lose some: variation in bone growth, gain and loss across the skeleton

PATRICK BEAUCHESNE<sup>1</sup> and SABRINA C. AGARWAL<sup>2</sup>

<sup>1</sup>Behavioral Sciences, University of Michigan, Dearborn, <sup>2</sup>Anthropology, University of California, Berkeley

In the past two decades, one of the most important themes in Dr. Stout's work has been his emphasis on the heterogeneity of the skeleton, both within elements and between. Studies that utilize a life course approach to examine bone aging and loss highlight the individual and population-level variability that is present within the skeleton during growth and later adulthood. In this paper we test the hypothesis that bone mass and maintenance in trabecular bone sites vs. cortical bone sites will show differing patterns of age-related bone loss, with cortical bone sites showing sex difference in bone loss that are similar to contemporary Western populations. We investigated this hypothesis in the Imperial Roman population of Velia using three methods: radiogrammetry of the second metacarpal ( $N = 71$ ), bone histology of ribs ( $N = 70$ ) and the analysis of lumbar trabecular bone architecture ( $N = 47$ ). The results show differences in the timing of bone loss with each method, but all methods find no statistically significant sex differences in age-related bone loss. We argue that a multi-method approach reduces the influence of confounding factors by building a reconstruction of bone turnover over the life cycle that a limited single-method project cannot provide. The implications of using multiple methods beyond studies of bone loss, and how this work intersects with Dr. Stout's contributions, are also discussed.

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### A deformation-based approach to the frontal lobe morphology in OH9, UA 31 and Bodo

AMÉLIE BEAUDET<sup>1</sup> and EMILIANO BRUNER<sup>2</sup>

<sup>1</sup>Department of Anatomy, University of Pretoria, South Africa, <sup>2</sup>Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain

Frontal lobes are considered key cerebral areas in human brain evolution, particularly because of the role of the frontal cortex in executive functions and language. Apart from general brain size

variation, the morphology of the frontal lobes did not display major differences among species of the human genus. Nonetheless, some changes in frontal proportions have been described in modern humans and Neanderthals, deserving further enquiries. In this study we describe the frontal lobe morphology of three Early to Middle Pleistocene African key specimens: OH 9 (*H. erectus*, c. 1.4 Ma, Tanzania), UA 31 (*H. erectus-ergaster*, 1 Ma, Eritrea), and Bodo (*H. heidelbergensis*, c. 0.6 Ma, Ethiopia).

Using digital endocasts, frontal lobe form comparison is performed through a landmark-free registration method based on surface deformation, and both local and global information are used to compute topological mapping of shape differences.

When compared with a modern human endocast, the three specimens display some differences. The frontal lobes of OH 9 are generally flatter, throughout their dorsal surface, while in the case of UA 31 and Bodo flattening is more restricted to the upper lateral areas. Whenever, at the Eastern African regional scale, these three fossils express some time-related morphoarchitectural evolutionary trends, therefore we must assume that frontal areas underwent first a general bulging of the whole dorsal surface, then a further dilation of the upper lateral surface.

Interestingly, in the modern cast this method does not evidence any consistent relative widening of the lower frontal areas, including the third frontal circumvolution.

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### A New Method for Estimating Age from Deciduous Teeth in Archaeological Contexts

JESS BECK

Anthropology, University of Pittsburgh

Teeth are well represented in the prehistoric record, and bioarchaeologists have developed many techniques to obtain demographic information from human dentition. Existing methods, such as modifications of the Miles method, are used to estimate adult age, and use of developmental standards like the London Atlas can estimate subadult age based on patterns of dental development and eruption. However, to date there is no method that allows for the estimation of age for loose, apex complete deciduous teeth. Here, I describe a newly developed method that regresses estimated midpoint ages (calculated using level of development of the developing sample) against wear in order to estimate the age of loose apex complete deciduous teeth. This method was developed for a sample of over 200 loose deciduous teeth from Necropolis 4 at the Copper Age

(c.3250-2200 cal BC) site of Marroquíes Bajos, in Jaén Spain. Results from the subadult regression model showed that an approach which removed high leverage observations produced the strongest predictive equation, making it possible to estimate age from loose deciduous teeth that have finished development and are apex complete. When combined with a modified Miles method and a sample-specific odontometric approach, it was possible to estimate age and assess sex of both adult and subadult individuals at Necropolis 4. This new method makes it possible to obtain important demographic information about a bioarchaeological sample even when a portion of the sample is composed of fully developed loose deciduous teeth.

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### Sixth Lumbar Sacralization and Familial Relatedness among Tiwanaku Individuals Buried at M70 in Moquegua, Peru

SARA K. BECKER<sup>1</sup>, BRIANNA E. HERNDON<sup>2</sup>, GENESIS TORRES MORALES<sup>3</sup> and PAUL S. GOLDSTEIN<sup>4</sup>

<sup>1</sup>Dept. of Anthropology, University of California, Riverside, <sup>2</sup>Dept. of Anthropology, University of California, Riverside, <sup>3</sup>Behavioral Science Department, York College of Pennsylvania, <sup>4</sup>Dept. of Anthropology, University of California, San Diego

Research on the Tiwanaku culture (AD 500-1100) describes the migration of highlanders into the lower elevation Moquegua Valley of Peru as diasporic family groups of colonizers. We present a likely case of familial relatedness from one Tiwanaku cemetery population, M70, in the Rio Muerto site group in the Moquegua Valley. Of the 74 burials from M70, 14 individuals (19%) have a sixth lumbar (L6) vertebra and almost all show L6 fully fused to the sacrum (i.e. sacralization). Clinical studies in modern humans note a sixth lumbar vertebra appearing in only 10% of the population. Sacralization of the fifth lumbar vertebra is also deemed rare, occurring in less than 20% of modern populations. The appearance of both of these traits, L6 with sacralization, is considered extremely rare. As this trait appears in 19% of all individuals from M70, and 39% (13 of 33) of M70 adults, it likely indicates some degree of genetic relatedness, supporting Tiwanaku colonial settlement as familial. We also see this trait in both sexes almost equally and among adults as young as 17 and as old as 60, with the one subadult age 12-15. Comparatively, there are two individuals at the nearby M43 site in the Rio Muerto group who have L6 sacralization (out of 25), while only two individuals at other Tiwanaku sites in Moquegua (i.e. M1, M10) or one in the highlands (i.e. Lukurmata). Thus, we explore the rarity of this trait and its relative uniqueness in people from the M70 site.

*Research funded by the University of California, Riverside*

## ABSTRACTS

### Reconstruction of the spinal curvatures in hominins, where do we stand?

ELLA BEEN<sup>1,2</sup>, ASIER GÓMEZ-OLIVENCIA<sup>3,4,5</sup> and ALON BARASH<sup>6</sup>

<sup>1</sup>Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University, Israel, <sup>2</sup>Physical Therapy, Ono Academic College, Israel, <sup>3</sup>Centro Mixto UCM-ISCIII de Evolución, Spain, <sup>4</sup>Ikerbasque, Basque Foundation for Science, Spain, <sup>5</sup>Department of Stratigraphy and Paleontology, University of the Basque Country, Spain, <sup>6</sup>Faculty of Medicine in the Galilee, Bar Ilan University

Reconstruction of the spinal curvatures of extinct hominins is essential in order to understand their posture and function. Despite its importance, researchers face many difficulties when trying to reconstruct spinal posture based on osseous material alone due to the absence of soft tissues.

In this paper, we will summarize the current methods for spinal curvature reconstruction based on osseous material. As an example, we will apply it to the vertebral column of the Kebara 2 Neandertal, and present the 3D reconstruction of its spinal curvature.

Two methods- Pelvic Incidence (PI) and Sacral Anatomical Angle (SAA) are used to describe sacral orientation. Both methods are applicable when there is a relatively complete pelvis. Three methods – Lumbar Vertebral Body Wedging (LVBW), Inferior Articular Process Angle (IAPA) and Lumbar Lordosis based on PI (LLPI) can define lumbar lordosis. Two methods- Thoracic Vertebral Body Wedging (TVBI) and Thoracic Vertebral Body Height Difference (TVBHT) define Thoracic Kyphosis. Finally, two methods - Foramen Magnum Orientation (FMO) and Cervical Vertebral Body Wedging (CVBW) can define the cervical lordosis.

The calculated values for Kebara 2 are PI:34°, SAA:19°, IAPA:25°, LLPI:29°-36°, TVBHT:44°, FMO:26°.

The different methods are consistent in each anatomical region and their combined use provide a more robust estimate. The plethora of methods can help researchers adopt the appropriate one for their needs. In order to conduct an educated discussion, paleoanthropologists should adopt the orthopedic approach, i.e. describe spinal curvatures by angular variables rather than the general phrase of human like or non-human like spinal curvatures.

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### Taxonomic Diversity among Central European Miocene Hominids

DAVID R. BEGUN<sup>1</sup> and MADELAINE BÖHME

<sup>1</sup>Anthropology, University of Toronto, <sup>2</sup>Senckenberg Centre for Human Evolution and Palaeoenvironment (HEP), University Tübingen

Nine teeth from Swabian Alb region of Southern Germany are among the first ever identified fossil hominid remains. Two genera have been recognized based on these teeth, *Neopithecus* and *Dryopithecus*. *Neopithecus* has next priority after *Dryopithecus* over all other genus-level nomina based on fossil ape holotypes. Recently, *Hispanopithecus* has also been recognized, based on a tooth from Trochtelfingen. To test this hypothesis and assess the usefulness of the *Neopithecus* holotype, I re-examined the six original specimens in Tübingen and high quality casts of the three specimens in Stuttgart. The Swabian Alb sites are derived from a karstic underground river system with specimens deposited in fine muds (M. Boehm, personal communication.) Specimens from these sites, including non-primates, have been polished by deposition and transport in the karst. This polishing accounts for nearly all of the differences identified as being of taxonomic significance within the primate sample. *Neopithecus* for example, has been distinguished from *Dryopithecus* in having lower cusps with apparently thicker enamel. In reality, the polishing accounts for this pseudomorphology. The sample of isolated teeth from the Swabian Alb are inadequate, given their unusual preservation, to represent types. *Neopithecus* is therefore a nomen dubium. There is no evidence for more than one taxon for all of the teeth from the Swabian Alb, with the exception of SMNS 43460, which is clearly a crouzelid pliopithecoid  $M_2$ . More analysis is needed to determine the precise taxonomic affinities of the remaining eight teeth.

*This study was funded by the Wenner-Gren and Leakey Foundations and by NSERC and the University of Toronto.*

### Homerange and sleeping site use by the Critically Endangered Cat Ba langur (*Trachypithecus poliocephalus*)

REBECCA L. HENDERSHOTT<sup>1</sup>, ALISON M. BEHIE<sup>1</sup> and BENJAMIN M. RAWSON<sup>2</sup>

<sup>1</sup>School of Archaeology and Anthropology, The Australian National University, <sup>2</sup>Vietnam Program, Fauna&Flora International

Home range size and habitat utilisation are affected by access to key resources including food, water and sleeping sites, all of which change seasonally. Limestone langurs (a group within the *Trachypithecus* genus) live on limestone karst hills with shrubby, stunted, and discontinuous vegetation. This study assesses home range size and sleeping site use in two groups of Critically Endangered Cat Ba langurs (*Trachypithecus*

*poliocephalus*). Over 180 days of observations, we found that the larger group (n=10-13) had a home range size of 50ha, while the smaller group (n=7) ranged within a 22ha area. There was also a small 5 ha area of home range overlap, which represents 10% of the larger group and 24% of the smaller group's home range; although this area was not used at the same time. Home range sizes increased in the wet season, which may reflect the need to spend more time searching for fruit, which is eaten more at this time of year. Most sleeping sites were ledges (61%) followed by caves (17%), however the caves that were used seemed to be preferentially chosen. Sleeping sites did not vary seasonally. The lack of reuse on consecutive nights indicates they may be chosen to provide safety from predators (primarily humans). This is the first long-term behavioural study of this highly threatened species to assess patterns of home range use and sleeping sites. This is key to conservation management planning as it can provide a measure of habitat use, which has implications long term viability.

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### Sexual dimorphism of the upper face, mandible and palate in elite of early medieval population from the Central Europe

ŠÁRKA BEJDOVÁ<sup>1</sup>, JÁN DUPEJ<sup>1,2</sup>, JANA VELEMÍNSKÁ<sup>1</sup>, LUMÍR POLÁČEK<sup>3</sup> and PETR VELEMÍNSKÝ<sup>4</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>2</sup>Department of Software and Computer Science Education, Faculty of Mathematics and Physics, Charles University, <sup>3</sup>Institute of Archaeology, Academy of Sciences of the Czech Republic, Brno, <sup>4</sup>Department of Anthropology, National Museum, Czech Republic

Sexual dimorphism of the facial skeleton is population-specific and, in addition to internal factors, is defined by the individual's environment. Unfavorable living conditions may result in less pronounced sexual dimorphism. In this study, we compare sexual dimorphism of the facial skeleton in Great Moravian (GM) elite and recent population. In GM, despite the documented good living conditions, we expected less sexual dimorphism than in current population.

The studied GM sample (9<sup>th</sup> and 10<sup>th</sup> century) comprised 105 individuals (54 males, 51 females), while the current population was represented by 106 individuals (59 males, 47 females). Three-dimensional surface models of the skulls were created from CT scans. The facial skeleton was divided into three areas: upper face, mandible and palate. Landmark data were processed using geometric morphometrics. Size, shape and form were analyzed separately.

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In all facial segments, significant sexual dimorphism was found. Even though the supraorbital area of the skull is typically the most sexually dimorphic part, in our study the mandible had the greatest discriminatory power. Using its form, 80.4 % of the GM sample and 93.5 % of the recent sample was correctly classified, in terms of sex. The greatest differences in shape in both populations were localized at *angulus mandibulae*. As expected, in GM population, we detected less sexual dimorphism than in the recent population. Our results show that sexual dimorphism of the mandible is population-specific and reflect the lower socioeconomic standard in the early medieval elite of GM, in comparison to current population.

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### Standardised osteological recording of archaeological skeletal material using an Oracle platform database: The Wellcome Osteological Research Database (WORD)

JELENA J. BEKVALAC

Centre for Human Bioarchaeology, Museum of London

Within the field of physical anthropology the demand for researchers to accessible osteological collections and data increases. Challenges are faced within institutions with holdings of human skeletal remains in selecting which methods to employ to record and share information, with data support issues in an ever changing digital technology. The Museum of London (MoL) through the Centre for Human Bioarchaeology (CHB) curates c.20,000 archaeologically derived human skeletal remains, a unique collection of stratified remains charting the development of the history of London through the people. They are an invaluable research resource of national and international significance but posed a challenge for how to most efficiently and effectively capture the osteological data, support it in the long term and make available for access to researchers with confidence in the data. Funding from the Wellcome Trust in 2003 established the CHB enabling the MoL to be a leading light in the approach for accessible standardised and digitised osteological data, with the development and creation of the Wellcome Osteological Research Database (WORD), an inter relational database supported on an Oracle platform. The database is a powerful research engine and dynamic tool for curated collections and for reburied collections provides digital access to a virtual collection. Since launching in 2007 the data downloads freely available from the CHB website with the method statement and database manual, have proved an invaluable research tool accessed and utilised by researchers worldwide. It has proven

the importance for such an application and the need for continued development.

### The Metagenomic Analysis of Oral Microbiome Composition of Dental Calculus Recovered from Institutionalized Individuals from the Mississippi State Asylum, Jackson MS

JONATHAN R. BELANICH<sup>1,2</sup>, HEATHER R. JORDAN<sup>1</sup>, MOLLY K. ZUCKERMAN<sup>2</sup>, NICHOLAS P. HERRMANN<sup>3</sup>, SHANE MILLER<sup>2</sup> and JASON ROSCH<sup>4</sup>

<sup>1</sup>Department of Biological Sciences, Mississippi State University, <sup>2</sup>Department of Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>3</sup>Department of Anthropology, Texas State University, <sup>4</sup>Infectious Diseases Department, St. Jude Hospital

Bacteria present within the human oral microbiome are integral to maintaining and preserving health and immunity. The microbial community can affect both oral and systemic health, and therefore composition can function as an indicator of disease. Consequently, a metagenomic analysis of the microbial communities preserved in dental calculus may allow for the generation of previously inaccessible reconstructions of microbial genomes from the past. By analyzing these, patterns of virulence and pathogenicity could be established, providing high-resolution, profiles of pathogenic diseases in the past, which can be compared against archaeological and skeletal data. Preserved dental calculus was analyzed from (N=4) 20<sup>th</sup> century skeletons recovered from the Mississippi State Asylum (1855-1935), a mental asylum in Jackson, MS. Isolated bacteria DNA was sequenced using shotgun metagenomic sequencing, and analyzed through a metagenomics toolkit. Previous reporting focused on the community-level characterization of the microbiomes whereas here, the analysis focused on the metagenome. Preliminary results reveal an average percentage of reads of  $3.105 \pm 0.792$  that were classified to taxonomic level, allowing for meaningful analysis of the metagenome. Research into these samples has potential to uncover additional novel information on the microbiome; these analyses can be utilized to examine the presence of virulence genes within pathogenic bacteria that were present in the oral microbiome in the pre-antibiotic early 20<sup>th</sup> century. By examining the metagenome, specific genes can be analyzed to establish host-microbe connections, thus adding to the small but growing body of paleopathological research into the health of marginalized and institutionalized populations.

### The unusual and generically distinct face of the middle Miocene small-bodied ape "*Micropithecus*" *leakeyorum* from Maboko Island, Kenya

BRENDA R. BENEFIT, MONTE L. MCCROSSIN and ERICA DAVIS

Anthropology, New Mexico State University

Small-bodied "apes" from the Miocene of Africa are an enigmatic group. Five new cranial specimens of "*Micropithecus*" *leakeyorum* from 15 my deposits at Maboko provide evidence about its craniofacial morphology and relationships.

The maxillary sinus of "*Micropithecus*" *leakeyorum* is anteriorly placed, originating immediately behind the canine root as in *Pan* and *Kalepithicus* (KNM-SO 417). Maxillary sinuses of *Aegyptopithecus*, *Limnopithecus*, and *Lomorupithecus* extend only to P4/M1 and of other catarrhines less far anteriorly. Postcanine lateral inflation of maxilla KNM-MB 29101 externally resembles *Cebus* and *Lagothrix* but no other catarrhine. Other catarrhine postcanine maxillary bone is either depressed (canine fossa) to varying depths, or is neither inflated nor depressed as in *Pliopithecus*, *Micropithecus clarki*, *Simiolus*, and *Pliobates*.

Maximum lateral expansion of the "*Micropithecus*" *leakeyorum* maxillary sinus occurs at the zygomatic root above and lateral to M<sup>2</sup> as in most catarrhines, and unlike the rare anterior position above M<sup>1</sup> in *Cebus*, *Cacajao*, *Chiropotes*, *Lomorupithecus*, *Oreopithecus*, some *Pongo*, and *Kenyapithecus* (*K. wickeri* and *K. africanus*).

The orbital rim of "*Micropithecus*" *leakeyorum* is positioned well anterior to the zygomatic root as in *Aotus*, *Lagothrix*, *Pliopithecus*, *Lomorupithecus*, *Micropithecus clarki*, *Pliobates*, and hylobatids. However, of these anthropoids only "*Micropithecus*" *leakeyorum* and *Lagothrix* share a convex rather than planar anterior surface of the zygomatic/maxilla.

Facial height below orbitale is significantly taller in "*Micropithecus*" *leakeyorum* (FACH/P3Width=281) than *Micropithecus clarki* (FACH/P3Width=228). Only *Aotus* (FACH/P3Width=182) has a shorter face than *M. clarki*.

Craniofacial and other evidence indicates that "*Micropithecus*" *leakeyorum* is generically distinct from all other catarrhine genera.

*Fieldwork and analysis supported by National Science Foundation, LSB Leakey Foundation, Wenner-Gren Foundation, Fulbright Collaborative and National Geographic Foundation.*

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### **Sizing up Strangers: Sexual Selection and Vocal Signals in Male Geladas (*Theropithecus gelada*)**

MARCELA E. BENÍTEZ<sup>1,2</sup>, THORE J. BERGMAN<sup>2,3</sup> and JACINTA C. BEEHNER<sup>1,2</sup>

<sup>1</sup>Anthropology, <sup>2</sup>Psychology, <sup>3</sup>Ecology & Evolutionary Biology, University of Michigan

Geladas live in extraordinarily large groups that can exceed 1000 individuals, yet the males in gelada society do not recognize other males around them – even males that they encounter on a daily basis. This creates a problem for males competing for mates – how do males make informed decisions about unknown rivals? One solution is that gelada males use a sexually-selected signal as a proxy for assessment. Here, we examined a putative sexually-selected signal for male geladas – the loud call used in male displays – from a population of wild geladas in the Simien Mountains National Park, Ethiopia. For the loud call to be a sexually-selected signal, it must (1) vary between males, (2) elicit differential responses from conspecifics, and (3) influence reproductive success. First, we found that acoustic features of loud calls reliably signal male condition with high-status males producing more calls, at a lower-frequency, and with a greater vocal range. Second, in simulated signal displays, gelada male subjects discriminated between loud calls based on the acoustic quality of the signal as well as their own status and quality. Females neither attended to loud calls nor differentiated between calls of high- and low-quality. Third, males that produced the strongest vocal signals exhibited the longest tenures and sired the most offspring based on genetic estimates. These results highlight the importance of rival assessment, rather than mate choice, in the evolution of loud calls in male geladas.

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### **Exploration of craniometrics variation along the Nile River**

CAITLIN R. BENNETT<sup>1</sup> and ANN H. ROSS<sup>2</sup>

<sup>1</sup>Anthropology and Sociology, North Carolina State University, <sup>2</sup>Biological Sciences, North Carolina State University

Egypt's unique geographical setting can be interpreted historically as a location vulnerable to migration and colonization or an isolated oasis. The aim of the investigation is to use traditional craniometrics to examine biological variation in three samples from the 11<sup>th</sup> Dynasty to the Christian Period with the expectation of regional genetic continuity. Measurements were collected from 271 crania from the Von Luschan Collection housed at the American Museum of Natural History in New York City, New York. The samples are from archaeological sites from El-Hesa

(n=142) in Nubia, from Gizeh (n=36), and Thebes (n=39) in Egypt.

From the measurements, size is defined as the geometric mean. Shape was calculated by dividing each variable by the geometric mean. An ANOVA was used to examine size differences between the sites, which showed no statistically significant size differences ( $p < 0.07$ ). The Mahalanobis squared distances showed significant differences between the groups and the most closely related were Gizeh and Thebes (El-Hesa and Gizeh = 66.07,  $p < 0.0001$ ; El-Hesa and Thebes = 65.532,  $p < 0.0001$ ; Gizeh and Thebes = 1.384,  $p < 0.071$ ). The unbiased minimum  $F_{ST}$  estimate between the populations using average heritability ( $h^2 = 0.55$ ) is 0.159. These results support regional continuity for Upper Egypt that could be attributed to geographical distance.

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### **Marginal perspectives within hegemonic spaces: the marronage of genomic technologies**

JADA BENN TORRES

Anthropology, Vanderbilt University

Genetic ancestry technologies advance our understanding of human evolution and biology, yet among the social sciences, the relationship between social and biological identities remains ambiguous and contested. In particular, social scientists argue that uncritical uses of genetic ancestry technologies reifies biological concepts of race. Furthermore, despite an increasing reliance on genetic ancestry techniques within biomedicine and direct-to-consumer testing companies, there has not been a robust movement within the social sciences that re-evaluates ideas about the relationship between race and contemporary genetics. Additionally, some genetic ancestry testing critics have warned against the proliferation of genetic techniques in lieu of methods that account for sociocultural factors that underlie health disparities. These critiques, in effect, isolate genetic ancestry technologies aligning them with contemporary iterations of scientific racism. Meanwhile, other researchers laud these same techniques for the potential to displace hegemonic narratives regarding marginalized communities as well as advance understandings about health disparities. To complicate issues further, very little academic research is available that explicitly studies how people's core ideas about race are altered (or not) by genetic ancestry data thereby bringing in to question claims about the effect of genetic technologies on popular perceptions of race.

Due to the inter-relatedness between genetics and environment, inclusive of sociocultural elements, it is important not to put genetic and social approaches in opposition, let alone privileging one over the other. Rather, educators and researchers should adopt a more nuanced

understanding of human genetic diversity that is firmly situated within appropriate bio- and socio-cultural contexts.

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### **Developmental effects on ovarian function**

GILLIAN R. BENTLEY

Anthropology, Durham University

Jim Wood has been a foremost and wide-ranging intellectual in the field of demography and reproduction. His 1994 interdisciplinary book, *Dynamics of Human Reproduction*, was a landmark in the field, combining one of the most comprehensible and readable accounts of the processes of human reproduction with quantitative and anthropological approaches. The book continues to stand the test of time despite accelerating knowledge in human reproductive biology. Jim's writing is a model for conveying complex ideas using elegant but simple prose. My time as a postdoctoral fellow with him in the 1990s had a profound and lasting influence on my academic life. My work progressed to focus on how early life development affects adult reproduction in order to explain the variation in ovarian function we commonly observe across populations. I owe Jim a huge debt that this short abstract cannot convey.

The poster summarised here will present an overview of my collaborative work during twenty years with migrant Bangladeshi women, representing a model to understand how the childhood developmental environment influences adult ovarian function. In short, women who grow up in more challenging environments that include stressors derived from infectious diseases, nutrition or energetics exhibit features that suggest lower ovarian function and a shorter reproductive lifespan. These characteristics include a later menarche, earlier menopause, lower rates of ovulation and lower levels of reproductive hormones and have implications for health across the life course.

This suite of studies, I like to think, builds on foundations I learnt from Jim Wood.

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### **Student Biological Anthropology Research in the Liberal Arts Environment: What to Do Without a Zoo?**

VICKI K. BENTLEY-CONDIT

Anthropology, Grinnell College

Although many anthropologists do substantial undergraduate teaching, many do not have access to zoos or museums. Yet, we want our students to engage in inquiry-based learning. Following are research projects from 100 (1st-year), 200 (2nd and 3rd-year), and 300-level (3rd and 4th-year) courses that achieve my goals of getting students to "do", think, and apply. In my 4-field introductory course, I present students with a set of casts/skulls and a list of names. Their assignment is to determine who's who

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by collecting qualitative and quantitative data, making short arguments for each. They then use their data to write two paragraphs that discuss "big picture" issues across the specimens. For my 200-level Primate Behavior class, I developed a baboon "fieldwork" CD. Students work through several steps (e.g., identification) and then use those skills to record behaviors from video clips. They utilize their data in a short paper addressing an issue from class discussions. In my 300-level Human Ethology course, my students develop an observation-based project, create an ethogram, and collect 10-14 hours of data. They analyze and incorporate their data as a "pilot study" for a NSF proposal. These are three examples of research students can do wherever they are located. All are modifiable. Each is designed so that students collect data, analyze/interpret it, use it, and submit a product. My experience is that students get a better idea of what it is like to "do" anthropology, learn more, and, ultimately, are more successful in the class. (Materials available upon request.)

### Sex-specific patterns in Age-related Cortical and Trabecular Bone Loss: A 2-D Histomorphometric Study using Mid-thoracic Ribs

AMY C. BERESHEIM

Anthropology, University of Toronto

This study provides histomorphometric bone loss data for South Africans who dealt with apartheid-era health issues. The sample consists of 206 individuals (nfemale=75, nmale=131, mean=47.9±15.8 years) from the Kirsten Skeletal Collection, University of Stellenbosch, and reflects the high degree of genetic and socioeconomic variability of the Cape Town metropole from the late 1960s to mid-1990s. To study bone quality and age-related changes in cortical and trabecular bone microarchitecture, photomontages of mid-thoracic rib cross-sections were quantitatively examined using two image-analysis software programs. Variables include Rt.Ct. Ar, OPD, On.Ar, BV/TV, Tb.N, Tb.Th, and Tb.Sp. The relationship between age and histomorphometric parameters was investigated through correlation analysis. Regression models tested for nonlinear associations and incorporated interaction terms to allow for sex-specific comparisons with age. When necessary, box-cox transformations were performed. Predicted values were used to estimate age-related changes from 20 to 80 years in both sexes.

All cortical variables demonstrate significant relationships with age in both sexes, with women showing stronger age-associations. In particular, greater predicted decrements in osteon size and relative cortical area for women suggest a structural disadvantage with age compared to men. Age-related changes in trabecular bone microarchitecture are more variable and less easily

characterized. This research highlights important sex-specific differences in patterns of age-related bone loss, and provides context for discussion of post-apartheid changes to bone health. While a significant proportion of the population is potentially at risk, osteoporosis research continues to be under-prioritized in South Africa.

### Health, inequality, and conquest in Warring States China

ELIZABETH S. BERGER<sup>1</sup>, LIANG CHEN<sup>2</sup>, JING SHAO<sup>3</sup> and ZHANWEI SUN<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of North Carolina at Chapel Hill, <sup>2</sup>School of Cultural Heritage, Northwest University, <sup>3</sup>Shaanxi Provincial Institute of Archaeology

This study compares three groups from two cemeteries of the Warring States period (475-221 BCE) in Shaanxi, China. The Zhaitouhe cemetery was used by a group from Western China known as the Rong, who lived under the State of Wei in the early Warring States period. The Shijiahe cemetery was possibly used by the Rong after the area was conquered by the State of Qin around 330 BCE, and was also used by a small number of Qin people who moved into the area after the conquest. Grave form and funerary goods, as well as a biodistance analysis, confirm the affinity of the two Rong groups and their cultural and biological distinctiveness from the Qin. However, many standard skeletal measures of health and diet show statistically significant differences between the Rong of Zhaitouhe and the Rong of Shijiahe, including in dental caries ( $\chi^2=9.5883$ ,  $p=0.0020$ ), periosteal lesions ( $\chi^2=9.5939$ ,  $p=0.0083$ ), and linear enamel hypoplasias ( $\chi^2=8.7062$ ,  $p=0.0032$ ), while the Rong people buried at Shijiahe closely resemble the Qin people in most measures. Moreover, the Rong of Shijiahe have worse oral health, higher frailty, and more childhood growth disruptions than the Rong of Zhaitouhe. Historical texts suggest that the Qin buried at Shijiahe were likely low-status individuals forced to move into the conquered area, and the Rong buried at Shijiahe were possibly those low-status members of their community who could not afford to flee the invasion. Ethnic affiliation and social status therefore intersect in these populations to influence diet and health.

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### Alternative instrument bags: assessing the accuracy and precision of the iGaging 8" Digital Outside Calipers

JACQUELINE M. BERGER<sup>1</sup> and KATIE E. FAILLACE<sup>2</sup>

<sup>1</sup>Anatomy and Neurobiology, Boston University School of Medicine, <sup>2</sup>Anatomy and Neurobiology, Boston University School of Medicine

Spreading calipers are an essential tool for biological anthropological analysis, enabling cranial measurements not possible with sliding calipers. Though manual spreading calipers are accepted as standard, the instruments are not without drawbacks including cost, readability, and weight. This study examines an alternative instrument, which alleviates these drawbacks, for accuracy and precision. Five measurements were recorded for 30 *Homo sapiens* crania by two observers. Accuracy and inter-observer error were assessed for the iGaging 8" Digital Outside Calipers and compared to GPM rounded end spreading calipers. Other features of the digital calipers were qualitatively observed and discussed, including ease of use and construction quality. Analysis of Variance found no significant difference (lowest  $p=0.993$ ) between measurements taken with both instruments. Inter-observer error analyzed using the Intra-Class Correlation Coefficient found high levels of agreement (lowest  $r=0.913$ ), demonstrating a higher level of agreement between users with the digital calipers ( $r>0.990$ ) than the manual calipers ( $r>0.960$ ), though significance was the same for all observer error ( $p=0.000$ ). Based on these findings, iGaging 8" Digital Outside Calipers may offer a reliable, cost-effective alternative for students and fieldwork; however, differences in construction quality mean they are not a direct replacement for the standard manual spreading calipers.

### Bioarchaeology of Violence and Disease at Forbush Creek, North Carolina

STEPH BERGER and DALE HUTCHINSON

Anthropology, University of North Carolina, Chapel Hill

First excavated in 1957, the Forbush Creek site (31 YD1) in Yadkin County, North Carolina, offers an important glimpse into the transition from the Early-Middle Woodland to Late Woodland Uwharrie phase (AD 700-1200) at the intersection of the western and northern Piedmont regions. This study analyzed the Forbush Creek human remains assemblage ( $n=55$ ) to better understand the lived experiences of individuals during this period of increasing consolidation, competition and conflict. Roughly half of the individuals in the sample ( $n=28$ ) were buried in ossuaries that contained the disarticulated, bundled remains of multiple individuals. The remaining individuals ( $n=27$ ) were recovered from primary, single pit internments set apart from the tight cluster of ossuaries. Although these burial contexts have comparable demographic profiles, individuals buried in the ossuaries exhibit significantly different frequencies of pathological lesions and trauma ( $\chi^2=16.5$ ,  $p<0.01$ ) compared to individuals buried in the primary single pit internments. 61% of the ossuary individuals exhibit cranial and post-cranial trauma, including one

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male (30-45 yrs) who suffered a healed post-cranial arrowhead wound and perimortem cranial fracture from two different traumatic events, and fewer pathological lesions. The individuals buried in the pit interments have no evidence of trauma, but 67% of the assemblage exhibits pathological lesions, and the related differential diagnoses include osteoarthritis, osteomyelitis, and scurvy. These results suggest that individual lifeways were impacted by changing cultural practices and social interactions as Late Woodland Uwharrie phase groups began to settle into nucleated sites and develop distinct tribal identities.

### Evidence of frequent hybridization in guenons (tribe Cercopithecini) from phylogeny with genome-wide markers

CHRISTINA M. BERGEY<sup>1</sup>, ANDREW S. BURRELL<sup>2</sup> and ANTHONY J. TOSI<sup>3</sup>

<sup>1</sup>Department of Anthropology, Pennsylvania State University, <sup>2</sup>Department of Anthropology, New York University, <sup>3</sup>Department of Anthropology, Kent State University

Guenons, tribe Cercopithecini, represent one of the most speciose and successful primate radiations. Distributed primarily in the rainforests of Africa, multiple taxa are usually found in sympatry and often form polyspecific associations. Guenons generally have colorful, diverse facial pelage patterns and a complicated history of chromosomal rearrangements, both of which may be related to the maintenance of species boundaries. Despite, or perhaps because of this, guenon evolutionary history is not yet clearly understood. Mitochondrial, sex-chromosomal, karyotype and blood protein phylogenies all conflict in some areas, and both differential sorting and hybridization likely account for a number of the discordances. Obtaining trees from many unlinked loci can help distinguish between these two processes. Here we present the most comprehensive guenon evolutionary trees to date based on multilocus double digest restriction site associated DNA sequence (RAD-Seq) data from >30,000 loci. We included representative samples from most of the guenon species, including at least one individual from each of the commonly-recognized species groups. We used several approaches to infer trees, including concatenation followed by estimation of a maximum likelihood tree with RAxML and a gene tree-species tree coalescent method implemented using SNAPP. We estimated divergence dates using BEAST with nodes calibrated via the fossil record. We also employed D statistics and F4 ratios to explore possible admixture between lineages. We find multiple instances of incongruence between gene trees and ascribe several of these patterns to reticulation between separate evolutionary lineages, highlighting hybridization as a significant force in shaping this speciose primate radiation.

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### Geography More than the Chronological Depth Explains the Structure of the Human Cranial Diversity

DANILO V. BERNARDO<sup>1</sup>, TATIANA F. DE ALMEIDA<sup>2</sup>, TAMIRES C. CAMPOS<sup>1</sup> and WALTER A. NEVES<sup>3</sup>

<sup>1</sup>Laboratório de Estudos em Antropologia Biológica, Bioarqueologia e Evolução Humana - Instituto de Ciências Humanas e da Informação, Universidade Federal do Rio Grande, <sup>2</sup>Laboratório de Estudos de Genes do Desenvolvimento - Departamento de Genética e Biologia Evolutiva - Instituto de Biociências, Universidade de São Paulo, <sup>3</sup>Laboratório de Estudos Evolutivos e Ecológicos Humanos - Departamento de Genética e Biologia Evolutiva - Instituto de Biociências, Universidade de São Paulo

In the last years, several works discussed the human variation from both genetic and craniometric data. These studies have demonstrated that the global amount of human variation, generally, decreases proportionally as increases their distance from Africa, suggesting a cline pattern as the better explanation to the structure of human variability. Some studies argued that other factors, as the geographic location of populations could have played a role in the process of diversification of human cranial morphology. Here, we used a sample represented by 5,993 skulls from 65 autochthonous populations of worldwide dispersion whose chronological range can be determined, to test if the chronological depth can interpose some effect in the cranial diversification. Our expectation is that if time played a role rather than geography in the process of morphological specialization we can infer that stochastic process may be considered as the main signature of this process. Each skull of the dataset was represented for 24 measurements taken in accordance with the Howells' protocol and both male and female specimens were used to perform analysis after the correction of size. We construct three types of Matrices: Biological, Geographical and Chronological, and compared them by means Mantel and Partial Mantel test. Our results shown that the correlation between Morphology and Geography ( $r=0.4173$ ;  $p=0.001$ ) is more adjusted than the between Morphology and Chronology (no statistical significance) to explain the human cranial diversity, suggesting that specific evolutionary conditions besides a unique stochastic process may played important role in the diversification of the human skull.

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### Perinatal death - a multitude of fetal and neonatal burials at the churchyard of Michelberg, Austria

MARGIT BERNER<sup>1</sup>, ANDREA STADLMAYR<sup>1</sup>, DORIS PANY-KUCERA<sup>1,2</sup>, ELISABETH RAMMER<sup>3</sup> and ERNST LAUERMANN<sup>4</sup>

<sup>1</sup>Dept. of Anthropology, Natural History Museum, Vienna, <sup>2</sup>Institute for Oriental and European Archaeology (OREA), Austrian Academy of Sciences, Vienna, <sup>3</sup>Zentrum für museale Sammlungswissenschaften, Donauuniversität Krems, <sup>4</sup>Landessammlungen Niederösterreich, Asparn a.d. Zaya

Studying skeletons of fetal and neonatal burials provides rare information about cultural practices and demography of former populations as well as about the environmental and health factors they had to cope with. The present study determines the minimum number of individuals (MNI) and age at death of numerous neonatal and fetal skeletons excavated at the top of the hill of Michelberg, Austria. The burials were discovered in the context of former medieval and postmedieval catholic churches and date from the 10<sup>th</sup>/11<sup>th</sup> to 17<sup>th</sup> century.

Fetal and neonatal ages at death were estimated using standard cranial and long bone measurements (Kósa 1989). MNI was calculated for each age class separately counting the most abundant skeletal element.

In total, at least 200 individuals from fetuses to adults were buried at the site. Of all individuals 70% were fetuses or neonates. Of the latter around 9% were estimated an age less than seven lunar months, whilst 17% died between seven and nine lunar months. The number of individuals who died prenatally is comparable to postmedieval swiss findings. In contrast, the number of infants who died within the first weeks of life is considerably higher at Michelberg. This mortality profile may reflect differences in cultural practices as well as poor nutritional or health status of the child and the mother.

Kósa F. (1989) Age estimation from the fetal skeleton. In: İşcan Y (ed.) Age Markers in the Human Skeleton, Charles C Thomas, Springfield, pp. 21–54.

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### Mother's milk oligosaccharides and infant gut microbiota: seasonality and infant outcomes in rural Gambia

ROBIN M. BERNSTEIN<sup>1,2</sup>, JASMINE C.C. DAVIS<sup>3,4</sup>, ZACHERY T. LEWIS<sup>4,5</sup>, SRIDEVI KRISHNAN<sup>6</sup>, SOPHIE E. MOORE<sup>8,9</sup>, ANDREW M. PRENTICE<sup>9</sup>, DAVID A. MILLS<sup>4,5,7</sup>, CARLITO B. LEBRILLA<sup>3,4</sup> and ANGELA M. ZIVKOIVC<sup>4,6</sup>

<sup>1</sup>Department of Anthropology, University of Colorado, Boulder, <sup>2</sup>Institute of Behavioral Science, University of Colorado, Boulder, <sup>3</sup>Department of Chemistry, University of California, Davis, <sup>4</sup>Foods for Health

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Institute, University of California, Davis, <sup>4</sup>Department of Food Science and Technology, University of California, Davis, <sup>5</sup>Department of Nutrition, University of California, Davis, <sup>6</sup>Department of Viticulture and Enology, University of California, Davis, <sup>7</sup>Elsie Widdowson Laboratory, Medical Research Council, <sup>8</sup>MRC Unit, The Gambia, Medical Research Council

Season of conception and birth in rural Gambia is related to infant morbidity and mortality, and a number of mechanisms ranging from epigenetic to immunological have been proposed to partially and additively account for these effects. Women experience seasonal fluctuations in food supply, energetic expenditure, and disease burden, and these factors influence maternal signaling to offspring *in utero* and in early postnatal life, through breast milk. Human milk oligosaccharides (HMOs) play an important role in the health of an infant as substrate for beneficial gut bacteria. We measured HMOs in mother's milk and infant gut microbiota in 33 mother-infant pairs living in the West Kiang District, The Gambia, and assessed their influence on infant morbidity and growth outcomes at 4, 16, and 20 weeks postpartum. Results indicate that a higher relative amount of milk lacto-N-fucopentaose I was associated with decreased infant morbidity ( $P=0.02$ ), and relative amount of 3-sialyllactose was found to be a good indicator of infant weight-for-age at 20 weeks ( $P=0.8 \times 10^{-6}$ ). Mothers nursing in the wet season produced significantly less total oligosaccharides compared to those nursing in the dry season. Bifidobacteria were the dominant genus in the infant gut overall; bacterial genera *Dialister* and *Prevotella* were negatively correlated with morbidity, and *Bacteroides* was increased in infants with intestinal inflammation (calprotectin  $>120$  mg/kg). Overall, our results suggest that in these populations, specific types and structures of HMOs are sensitive to environmental conditions, protective of morbidity, predictive of growth, and positively correlated with specific microbiota profiles.

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### Many ways to form a pit, but not a scratch: modelling and measuring dental microwear signatures

MICHAEL A. BERTHAUME, ELLEN SCHULZ-KORNAS and KORNELIUS KUPCZIK

Max Planck Weizmann Center, Max Planck Institute of Evolutionary Anthropology

Research into the etiology of dental microwear has focused primarily on the agents that cause wear and not the processes by which microwear features are formed. Here, we use finite element analysis (FEA) to investigate the processes by which particles can cause these features. A

parametric FE model consisting of two enamel blocks with a particle between the blocks was constructed. Non-linear, elastic, contact simulations were run where the upper enamel block was displaced into the particle, compressing it into the lower enamel block, while ingesta (particle size, shape, concentration, material properties) and masticatory (attack angle, bite force) characteristics were varied. The particle was constrained at its center with weak spring elements. Worn surfaces of the enamel were extracted and quantified using 3D surface texture method following ISO 25178. Regardless of phytolith shape, increase in particle size and mechanical properties, and bite force cause deeper, wider pits to form on the enamel, while increases in particle concentration increases the number of features. Decreases in attack angle cause pits to become elongated, eventually becoming scratches. The only way to obtain a scratch is through horizontal movement of a particle, irrespective of its shape, size, mechanical properties, or bite force. Factors unrelated to ingesta such as masticatory kinematics and bite force appear to play an important role in pit and scratch formation. In addition, the intensity of the dental microwear signature (depth/number of pits, length/number of scratches) is sensitive to particle size, concentration, shape, and mechanical properties, attack angle, and bite force.

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### Computerized cementochronology - taking the (16)bit between the teeth

BENOIT BERTRAND<sup>1</sup>, JOSÉ RAMOS MAGALHAES<sup>2</sup> and THOMAS COLARD<sup>1</sup>

<sup>1</sup>Lille University. Forensic Taphonomy Unit. Forensic Institute, Lille - France, <sup>2</sup>FEI Visualization Sciences Group, Saint-Aubin - France

Age-at-death estimation is a fundamental requirement for biological profile assessment in forensic anthropology and bioarchaeology. Cementochronology, that involves the count of acellular cementum increments on histological micrographs, is considered as an accurate and precise method to access the chronological age. However, cementochronology clearly suffers from the profusion in methodological protocols, from intra/inter-observer discrepancies and from implementation time. The main objectives of this presentation are: (i) to address the importance of establishing quality standards for the cementochronology protocol, namely through the certification according to the ISO-9001 that ensures the reproducibility of preparations (ii) to describe the development of a time saving module on the Visilog platform, which substitute the manual counting and eliminate factors such as subjectivity and tiredness of the investigator (iii) to present the results of the performance of this semi-automated tool on known-age

individuals, in order to evaluate the efficiency and to compare estimates.

The application of the software on 16-bit micrographs from one hundred histological slices from anatomical collections allowed us to evaluate the software accuracy and the concordance of counts with the observers. The time saving module on the Visilog platform detects and counts cementum ring structures at a speed and accuracy unmatched by other methods. The computerized estimation provides consistent results and narrows down the range of estimation. This work demonstrates that, once standardized and semi-automated, cementochronology is neither time-consuming nor subjective.

### Testing a novel method for collecting salivary cortisol from wild macaques

DOMINIQUE A. BERTRAND<sup>1</sup>, CELINE BRET<sup>2</sup>, CAROL M. BERMAN<sup>1,3</sup>, SUSAN W. MARGULIS<sup>4</sup>, MICHAEL HEISTERMANN<sup>2</sup>, AGIL MUHAMMAD<sup>5</sup>, UNI SUTIAH<sup>5</sup> and ANTJE ENGELHARDT<sup>2,6</sup>

<sup>1</sup>Anthropology Department, University at Buffalo, SUNY, <sup>2</sup>Primate Sexual Selection, German Primate Center, <sup>3</sup>Evolution, Ecology, & Behavior Program, University at Buffalo, SUNY, <sup>4</sup>Departments of Animal Behavior and Biology, Canisius College, <sup>5</sup>Faculty of Veterinary Medicine, Bogor Agricultural University, <sup>6</sup>School of Natural Sciences and Psychology, Liverpool John Moores University

Fecal sampling is the most prevalent, non-invasive method to measure stress hormones in wild primates. However, fecal glucocorticoid metabolites (fgcm) represent average concentrations (~24hrs after stressor). Therefore, there may be a lack of sensitivity to short term stress responses. Field ready, non-invasive salivary cortisol collection methods are in their infancy, but are useful because they detect finer tuned responses (~20-30min after stressor). This study describes a procedure to collect saliva from critically endangered, wild crested macaques (*Macaca nigra*) aiming to circumvent problems associated with fgcms. Salivary samples were collected over 22mo from three habituated groups of crested macaques in Tangkoko Nature Reserve, Sulawesi, Indonesia. We tested our collection protocol using Sarstedt salivary swabs soaked in different flavors. Isolated macaques were presented with "dropped" swabs when conditions allowed collectors to remain hidden from view. Macaques chewed swabs for several minutes and then spat them out. In preliminary tests, mango was the most popular flavor; males chewed 69.24% of swabs overall, increasing to 100% by study's end. Females were slow to accept/chew swabs until we more carefully hid ourselves, especially our eyes. For the main project, mango was no longer popular and was replaced with grape/currant. To date, we collected ~600 salivary samples from 27 monkeys (females:38%, males:62%). All samples were centrifuged, yielding at least 100ul each.

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Samples are currently frozen and awaiting assay. This procedure opens a new path to the noninvasive collection of saliva from primates, potentially allowing for the measurement of immediate stress responses in wild primates.

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### Urbanization's Impact: Health and Survivorship Patterns in Medieval Poland

TRACY K. BETSINGER<sup>1</sup> and SHARON DEWITTE<sup>2</sup>

<sup>1</sup>Anthropology, SUNY Oneonta, <sup>2</sup>Anthropology, University of South Carolina

Urbanization has been equivocally argued to cause significant negative health impacts in both historic and contemporary settings. Urbanization is associated with increasing population aggregation and increases in waste accumulation, which would increase exposure to and spread of pathogens. However, a recent bioarchaeological study of a medieval urban Polish population (AD 950-1250) found no trend of declining health based on various skeletal indicators, such as enamel hypoplasias, porotic hyperostosis, periostitis, and infectious diseases. Evaluation of survivorship is an alternative method of assessing whether a population experienced shifts in health. This study tests the hypothesis that there was no change in survivorship in a Polish population during three hundred years of urbanization.

Medieval Polish skeletal samples (n=85) from the city of Poznan were divided temporally: AD 950-1025 (n=17), AD 1025-1100 (n=41), and AD 1100-1250 (n=27). The midpoint of age ranges was used for all individuals. Initial analyses revealed minimal differences between the two later periods, so these were pooled for further analyses (AD 950-1025 vs. AD 1025-1250). The results of Kaplan Meier survival analysis indicate that survivorship declined significantly from 28.9 years to 20.4 years overall ( $p = 0.037$ ). Cox proportional hazards analysis reveals the odds of dying increased significantly over time ( $p=0.046$ ). Collectively, these results suggest a trend of increased mortality (and by inference, declines in underlying levels of health) over time, which is contrary to the hypothesis. This study demonstrates the need for multiple types of analyses to gain a more complete understanding of health trends in the past.

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### Modern Variation in the Shape of the Birth Canal and the Effects of Climate and Population History

LIA BETTI<sup>1</sup> and ANDREA MANICA<sup>2</sup>

<sup>1</sup>Department of Life Sciences, University of Roehampton, <sup>2</sup>Department of Zoology, University of Cambridge

Several studies have shown a wide range of variation in the shape of the female birth canal, part of which appears to be geographically structured. It is not clear, however, what the origin of such high variation is, both within and between human populations. I have previously shown that neutral evolutionary processes account for a large share of variation in the shape of the os coxae. Some aspects of pelvic shape have also been linked, by several authors, to climatic adaptation.

Our research tested whether worldwide variation in birth canal shape can be explained by neutral processes (i.e. drift and migration), and if climatic adaptation played a significant role. Measurements of the main diameters of the birth canal were collected from 348 female individuals from 24 globally distributed populations. We show that differences in the shape of the canal between populations are significantly correlated with neutral genetic distances (estimated from available genetic data from matching populations), a fact that confirms the important role of neutral evolutionary processes in shaping pelvic and canal morphology. We found no significant correlation between birth canal differences and temperature differences. Shape differences between geographic regions do not reflect past climatic adaptation, and have likely arisen from a stochastic drift towards different average shapes along the various routes of expansion of our species out of Africa.

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### No monkeys on campus? Engaging undergraduates using local natural history

MICHELLE BEZANSON and TAYLOR GROVES

Anthropology, Santa Clara University

SCU Gone Wild (SGW) is a community science and natural history initiative with a mission to characterize, record/preserve biodiversity on campus. It encourages observational data collection on campus and on field trips and/or field courses. We combine citizen science, long-term research, and community involvement in order to highlight natural history on and off campus. Faculty, students, community members, and entire courses are involved in several activities including bioblitzes, recording observations via iNaturalist, field notes, vegetation analysis, bird counts, researching landscape change,

and several longer-term research projects. For example, students that participate in the summer primate ecology course submit their independent field projects/data into an archive maintained by the library. In addition, we are collecting behavioral and positional behavior data on the campus squirrel population. Finally, we are tracking bird activity via bird counts and recording ecological data on nesting patterns. Thus far, SGW has served as an interdisciplinary initiative to highlight the importance of natural history studies and urban wildlife. This has encouraged participation in primate field courses and related field opportunities because students are able to gain experience in field data collection without leaving campus.

### The Dynamics of Fundamental Niche Parameter Fluctuation for Late Neandertals and Upper Paleolithic Humans in Western and Central Europe

RACHAEL C. BIBLE

Biodiversity Institute, University of Kansas, Department of Anthropology, Texas A&M University

Models of Late Pleistocene hominin evolution in Western and Central Europe ultimately seek to explore the dynamics of possible interaction between late-surviving Neandertals and the makers of Upper Paleolithic (UP) technologies, presumably early modern humans (EMHs). To investigate that question, this project utilizes Ecological Niche Modeling (ENM) methods using the Genetic Algorithm for Rule-set Prediction (GARP) to produce predictive presence/absence maps of fundamental niche parameters for three time periods: 1) Pre-H4 (43.3-40.2 ky cal BP), 2) H4 (40.2-38.6 ky cal BP), and 3) Post-H4 (38.6-36.5 ky cal BP) using data from Neandertal fossil sites, Middle Paleolithic (MP), and UP archaeological sites. All but one sample (the Post-H4 sample of Neandertal fossil localities) produced statistically significant models able to correctly classify omitted test points at a better than random rate. Models based only on locations of Neandertal fossil remains show the largest area predicted present during the Pre-H4, which reduces dramatically in the H4. The largest area predicted present for models using MP archaeological sites occurs during the H4, but becomes restricted to the southern Europe in the Post-H4. Models based on UP archaeological sites demonstrate a sharp increase in the Post-H4 of geographic areas predicted as present in comparison to the Pre-H4 and H4. These results demonstrate that the areas where contact between Neandertals and the makers of UP technologies most likely occurred also became restricted through time prior to Neandertal extinction and were most concentrated in southern France and northern Spain during the Post-H4.

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## Measuring bacterial communities in the humerus to estimate PMI

SARAH E. BIVENS, ERIC DAVID and NICHOLE RUBLE

Biology, Sam Houston State University

Methods of estimating postmortem interval (PMI), or time since death, are largely dependent on changes in soft tissues, and the sampling of insects and bacteria. These traditional methods are influenced by several biotic and abiotic factors, such as moisture, temperature and geography. The interior of marrow-containing bones, however, are largely protected from many of these variables, and also persist much longer in the environment. Our research, therefore, focuses on estimating PMI based on bacterial community composition and succession in marrow-containing bones. We hypothesize bacterial communities inside the human humerus will change in a predictable and consistent manner. We began sampling three cadavers (two males and one female) at Southeast Texas Applied Forensic Science (STAFS) facility in Huntsville, Texas, in May, 2016. Over four months, the left humerus was sampled every two days and the right humerus every eight days as a control for contamination. We used sterilized T-Lok bone marrow biopsy needles and a sterilized drill to extract marrow samples, and froze samples for shipment to Baylor School of Medicine. Microbiota were measured by deep sequencing of the 16S rRNA gene specific to bacteria, and statistical analysis of bacterial communities were determined using UniFrac. Preliminary results suggest that bacterial communities inside the humerus change at a predictable rate and are largely consistent across specimens. The results of this research could provide for improved methods of estimating PMI, which will be a valuable tool for forensic scientists and law enforcement.

## Seed Dispersal Effectiveness in Two Populations of Bornean Orangutans (*Pongo pygmaeus wurmbii*)

ANDREA BLACKBURN<sup>1</sup>, SHAUHN E. ALAVI<sup>2,3</sup>, PRIMA LADY<sup>4</sup>, RIYANDI<sup>5</sup>, ERIN R. VOGEL<sup>2,3</sup> and CHERYL D. KNOTT<sup>1</sup>

<sup>1</sup>Anthropology, Boston University, <sup>2</sup>Anthropology, Rutgers University, <sup>3</sup>The Center for Human Evolutionary Studies, Rutgers University, <sup>4</sup>Biology, Universitas Nasional, <sup>5</sup>Biology, University of Tanjungpura

Orangutans consume large quantities of ripe fruit and disperse intact seeds over wide areas. However, few studies have quantified seed dispersal in orangutans (Galdikas 1982; Nielsen

et al. 2012). We hypothesized that orangutans are effective seed dispersers. This was tested by identifying, measuring and counting seeds in orangutan feces and recording fecal coordinates to determine seed spatial distribution patterns. Orangutan feces were collected opportunistically from March- September 2015 at the Tuanan Research Station (n=97) and from July- August 2016 at the Cabang Panti Research Station in Gunung Palung National Park, Indonesia (n=98). The feces were sieved, seeds were counted, and seed morphotypes were identified in at least 96% of fecal samples. Flanged males, unflanged males, adult females, and juveniles independent enough from their mother to allow for fecal collection, were all observed dispersing seeds. Four fruit genera were dispersed at Cabang Panti and nine fruit genera were dispersed at Tuanan. At Cabang Panti, the largest intact seed size recorded was 2.29cm in length and the smallest seeds dispersed were less than 1mm *Ficus* seeds. At Tuanan, 31% of fecal samples had 2 or more genera, 42% had 1 genera, and 26% had no seeds. We used descriptive GIS to describe the spatial distribution of the dispersed seeds. We concluded that orangutans have an important role in fruit tree recruitment. They disperse intact seeds of varying sizes and disperse several different genera of seeds. Future research will measure seed dispersal distances and orangutan gut-passage rates to establish the orangutan seed shadow.

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## Immune function across the life-span in Amazonian horticulturalists

AARON D. BLACKWELL<sup>1,2</sup>, BENJAMIN C. TRUMBLE<sup>2,3,4</sup>, IVAN MALDONADO SUAREZ<sup>2</sup>, JONATHAN STIEGLITZ<sup>2,6</sup>, BRET BEHEIM<sup>2,5,7</sup>, J. JOSH SNODGRASS<sup>8</sup>, HILLARD KAPLAN<sup>2,5</sup> and MICHAEL GURVEN<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of California, Santa Barbara, <sup>2</sup>Tsimane Health and Life History Project, <sup>3</sup>Center for Evolution and Medicine, Arizona State University, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University, <sup>5</sup>Department of Anthropology, University of New Mexico, <sup>6</sup>Institute for Advanced Study in Toulouse, <sup>7</sup>Department of Human Behavior, Ecology, and Culture, Max Planck Institute for Evolutionary Anthropology, <sup>8</sup>Department of Anthropology, University of Oregon

Amazonian populations are exposed to diverse parasites and pathogens, including protozoal, bacterial, fungal, and helminthic infections. Yet much of our understanding of the immune system is based on industrialized populations where these infections are relatively rare. We examine distributions and age-related differences in 22 measures of immune function for Bolivian frager-horticulturalists and US and European

populations. Subjects were 6,338 Tsimane aged 0-90 years. Blood samples collected between 2004-2014 were analyzed for 5-part blood differentials, C-reactive protein, erythrocyte sedimentation rate (ESR), and total immunoglobulins E, G, A, and M. Flow cytometry was used to quantify naive and non-naive CD4 and CD8 T cells, natural killer cells, and B cells. Compared to reference populations, Tsimane have elevated levels of most immunological parameters, particularly immunoglobulins, eosinophils, ESR, B cells, and natural killer cells. However, monocytes and basophils are reduced and naive CD4 cells depleted in older age groups. Tsimane ecology leads to lymphocyte repertoires and immunoglobulin profiles that differ from those observed in industrialized populations. These differences have consequences for disease susceptibility and co-vary with patterns of other life history traits, such as growth and reproduction. Moreover, an understanding of immune function under high pathogen stress may help us to understand the emergence of many non-infectious diseases in industrialized populations where pathogen stress is low.

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## Tooth size, trait expression, and nutritional stress

ERIN C. BLANKENSHIP-SEFCZEK<sup>1</sup>, DEBBIE GUATELLI-STEINBERG<sup>1</sup> and ALAN H. GOODMAN<sup>2</sup>

<sup>1</sup>Anthropology, Ohio State University, <sup>2</sup>Anthropology, Hampshire College

Physiological disruption, e.g. nutritional stress, often results in a slowing of growth and development in human biological systems. We investigated the relationship between nutritional stress and dental characteristics (crown size and trait expression) in maxillary dental casts of adolescents from Tezonteopan, Mexico. The unique casts are from individuals (n=34) who were provided daily nutritional supplements early in development and others (n=39) who were not (Chavez and Martinez, INN, Mexico City, 1979). We recorded buccolingual and mesiodistal diameters, and trait expression following ASUDAS. Based on previous research on nutritionally stressed samples, we predicted that teeth of the non-supplemented group would exhibit more variable trait expression and smaller size than teeth of the supplemented group. As predicted, we found the supplemented group exhibited significantly larger lateral incisors and canines than the non-supplemented group. However, no significant differences in crown size were found for other tooth types. Unexpectedly, the supplemented group exhibited significantly higher degrees of expression for double-shovel and tuberculum dentale. Conversely, as predicted,

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molars in the non-supplemented group exhibited higher degrees of trait expression for M1 cusp 5 and M2 hypocone. Further analysis incorporating intercusp distance is planned to investigate this difference, as previous studies suggest that interactions between intercusp distances and tooth size are most closely correlated with variation in trait expression. These findings indicate that developmental environments, in this case mild to moderate undernutrition, influences human tooth size and morphology, despite a high degree of genetic control, and should be considered in biodistance studies that rely on dental traits.

### Individual differences in spatial position during collective movements of vervet monkeys

MARYJKA B. BLASZCZYK

Department of Anthropology, University of Texas at Austin

Collective movement is a fundamental mechanism by which social animals maintain group cohesion. In this study I explore possible predictors of position within group movements in two troops of wild vervet monkeys (*Chlorocebus pygerythrus*) in Soetdoring Nature Reserve, South Africa. A team of observers recorded individuals' relative positions during group progressions (N = 117) over 11 months. I examined the effects of sex and age class, dominance rank, and individual identity on whether or not individuals were positioned in the front third of group progressions using a binomial mixed-effects model. Individual identity contributed significantly to the variance, and a separate repeatability test revealed that presence in the front third was significantly repeatable. Neither age nor sex had an effect, but dominance rank predicted relative spatial position for both study groups. I conducted a separate model to test whether the personality trait 'boldness' predicted position for the subset of individuals who participated in a complete set of field experiments with novel objects. Boldness did not predict spatial position. In sum, individual vervet monkeys were consistent in their within-group spatial position during collective movements, but spatial position was not related to sex, age class, or boldness. Higher-ranking animals were, however, more likely to be found towards the front of the group during progressions. Future research is needed to examine other factors that may contribute to interindividual variation in position within collective movements.

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### The Evolution of Host-microbiome Interactions in Humans

RAN BLEKHMANN

Genetics, Cell Biology, and Development, University of Minnesota

Exciting new research is unraveling an extreme variation in the composition of microbial communities across primate species. The gut microbiota can regulate and train host immune response, perform important metabolic functions, produce nutrients, and protect against pathogen infection. While some of this variation is controlled by environmental factors, microbial composition is also heritable and shaped by host genetic variation. An important mechanism by which natural selection controls species-specific traits is by changing the regulation of gene expression. Comparing primate species, we and others have found that gene regulation can evolve under natural selection, potentially facilitating evolutionary adaptations in primates. In addition, changes in gene expression in the gut have a direct and marked impact on the composition of gut microbial communities. However, to date, we still do not understand how selection on primate gene regulation can facilitate adaptations in the microbiome. Here, we used a novel experimental system based on primary colonic epithelial cells co-cultured with live microbiomes extracted from four primate hosts (human, chimpanzee, gorilla, and orangutan), which enables dynamic profiling of host gene expression changes directly modulated by the microbiome. We find that the microbiome of different primate species elicits a species-specific response in host gene expression. In addition, genes that respond specifically to human microbiomes are enriched with genes that have been previously associated with microbiome-related health conditions. Our results suggest that the evolution of gene expression in primates might be affected by the symbiosis with gut microbial communities.

### Delineating the effects of early life experience on adult immune function in 20<sup>th</sup> Century Portugal

KELLY E. BLEVINS<sup>1</sup>, CHARLOTTE ROBERTS<sup>2</sup> and ANA LUÍSA SANTOS<sup>3</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Archaeology, Durham University, <sup>3</sup>Department of Life Sciences, Research Center for Anthropology and Health (CIAS), University of Coimbra

The developmental origins of health and disease (DOHaD) hypothesis proposes that adult health outcomes are influenced by events that occur during critical periods of growth and development. Contemporary DOHaD hypothesis research focuses on the implications for chronic disease, such as diabetes and obesity, but few studies have examined the impact of early life experiences on adult immune function. Skeletal

biologists have an advantage over medical researchers when doing longitudinal studies, as we can identify events chronicled in bone. This research takes advantage of the skeleton as an archive of physiological circumstance and tests the hypothesis that skeletal stress markers correlate to certain developmental windows and that the timing of physiological perturbations will differentially affect adult immune function. Multiple indicators of stress events were recorded in skeletons from the Coimbra Identified Skeletal Collection, Portugal in adult individuals who died of tuberculosis (n=125) and those who died of non-infectious causes (n=125). Using tuberculosis infection as a proxy for compromised immune function, this study found no significant differences in early life circumstance between individuals who had compromised immune function and those who did not. This suggests that either skeletal indicators of stress actually reflect an increased ability to adapt and survive physiological insults (predictive adaptive response) or that the long-term effects of adverse early life experiences can be eclipsed by the adulthood environment.

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### Forest Composition and Miocene platyrrhine distributions: Why are there No Fossil Monkeys in Florida?

JONATHAN I. BLOCH<sup>1</sup>, EMILY D. WOODRUFF<sup>1,2</sup>, ALDO F. RINCON<sup>1,3</sup>, PAUL E. MORSE<sup>1,4</sup>, ARIANNA R. HARRINGTON<sup>1,2,5</sup>, GARY S. MORGAN<sup>6</sup>, AARON R. WOOD<sup>1,7</sup> and NATHAN A. JUD<sup>1,8</sup>

<sup>1</sup>Florida Museum of Natural History, University of Florida, <sup>2</sup>Department of Biology, University of Florida, <sup>3</sup>Department of Geological Sciences, University of Florida, <sup>4</sup>Department of Anthropology, University of Florida, <sup>5</sup>Department of Evolutionary Anthropology, Duke University, <sup>6</sup>Department of Paleontology, New Mexico Museum of Natural History and Science, <sup>7</sup>Department of Geological and Atmospheric Sciences, Iowa State University, <sup>8</sup>School of Integrative Plant Science, Cornell University

South America was separated from North America by an ocean until ~3.5 Ma, when the emergence of the Isthmus of Panama linked the two continents. Recent discovery of *Panamacebus transitus*, a medium-sized (~2.7 kg) cebid primate from the early Miocene of Panama, shows that platyrrhines crossed into the tropical lowlands of Central America at least once by ~21 Ma. However, there is no record of platyrrhines in localities of similar age at higher northern latitudes, including the Gulf Coastal Plain where many mammal taxa are closely related to those found in Panama. While this absence might be explained by lack of suitable tropical forest habitats, contemporaneous South American platyrrhine distributions include the high latitudes of Patagonia, introducing a potential paradox whereby primates are limited to

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tropical forests in North, but not South America. A possible resolution lies in the taxonomic composition of the forests themselves. Early Miocene forests of tropical South America have a shared Gondwanan history with those at higher southern latitudes (Patagonia), and southern Central America (Costa Rica and Panama), which are dominated by South American-derived tropical rainforest taxa. Northern tropical Central American forests, however, have predominantly Laurasian affinities in the Miocene. The upper molars of *P. transitus* have shearing quotient and relief index values comparable to the frugivorous cebid *Aotus*. Northward dispersal of platyrrhines in the early Miocene was likely limited more by their niche conservatism and a boundary between forests with different evolutionary histories than by differences in climate or the existence of major geographic barriers.

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### **Crossing the divide: co-teaching human diversity and evolution to advanced biology and anthropology undergraduate students through the use of interdisciplinary research groups**

DEBORAH E. BLOM<sup>1</sup> and AMANDA L. YONAN<sup>2</sup>

<sup>1</sup>Anthropology, University of Vermont, <sup>2</sup>Biology, University of Vermont

Here we report on outcomes from a newly-developed, intensive seminar and lab-based course for advanced students majoring in Anthropology and Biology. The class integrates perspectives from biology and biological anthropology to investigate human evolution and diversity. Together the instructors and students engage, through critical analysis, reflective writing, discussion and practice, with a broad range of readings and laboratory methods from both disciplines. Where knowledge bases or epistemologies differ, instructors help guide students in their respective disciplines; peer-to-peer teaching also empowers students to take ownership over their learning. In the process of preparing a literature review and research proposal in interdisciplinary groups, students further practice effective research, writing, and collaboration skills.

By the end of the semester, students proved adept at evaluating human variation, at both individual and population levels, from a biocultural perspective. They questioned concepts such as "normal" and "natural" and challenged essentializing and reductionistic explanations for human evolution, biology and behavior. Additionally, by understanding what goes into producing, organizing and interpreting knowledge in their "two cultures," they learned that all researchers bring certain assumptions and see the world through particular lenses. Specifically, students were able to distinguish between research/theoretical

foci and social norms in biology and biological anthropology. Further, the class successfully met learning objectives required for both the anthropology and biology curricula and gained important transferable skills that employers report as most desired in college graduates. Finally, the instructors' professional development benefitted from this collaboration, and they enjoyed new intellectual challenges.

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### **The Importance of Ethnographic Data and Social Network Structures in Determining Infection Risk for Individuals in Rural Communities of Bangladesh and Uganda**

LAURA SP. BLOOMFIELD<sup>1,2</sup>, ASHLEY HAZEL<sup>3</sup> and JAMES H. JONES<sup>3</sup>

<sup>1</sup>Emmett Interdisciplinary Program in Environment and Resources/Medicine, Stanford University, <sup>2</sup>Medicine, Stanford Medical School, <sup>3</sup>Earth Systems Science, Stanford University

Rural communities in less developed nations have often been sites for devastating emerging infectious disease outbreaks. These areas provide the ecological context and human-animal interactions needed for an infection spillover event. Relatively low population sizes and high social connectedness may allow infections to spread very rapidly through rural communities. These areas may also be a source of mobile infectious individuals, who may ignite an epidemic in urban and peri-urban populations. Network models have been one valuable method for modeling epidemics and predicting patterns of outbreaks. Network science is a computational field that owes its fundamental principles to structuralism in anthropology. However, ethnographically derived data is often omitted from this work. In this study, fine-scale social data from two very different high-risk disease transmission environments illustrate the importance of cultural context and social network structure to disease risk. In both Ugandan and Bangladeshi communities, close-friend networks had very high levels of connectivity, as compared to networks based on other types of relationships. However, the social and demographic structures between these environments are quite different, driving different types of exposures. In Bangladesh, network density is driven by female participants and their female relatives who live in close proximity and have substantial social relationships. Whereas, in Uganda, network density is partially driven by male community leaders, who have large and extended friendship networks. Anthropologically informed and field-based network models can play an important role in predicting epidemic

dynamics in high-risk populations and offer insights for effective public health interventions.

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### **Growing up in Çatalhöyük : enamel hypoplasia and history houses**

EMMY BOCAEGE<sup>1</sup>, ANNA CLEMENT<sup>2</sup> and SIMON HILLSON<sup>2</sup>

<sup>1</sup>PACEA, UMR 5199, CNRS, MCC, Université de Bordeaux, <sup>2</sup>Institute of Archaeology, University College London

Çatalhöyük, a Neolithic settlement located in the Konya plain (7400–5900 BC), has a uniquely detailed archaeological record with a large number of excavated human remains. About two thirds of the sample are children and this provides an excellent opportunity for an in-depth study of human dental development. Here we focus on the variability in dental growth of children (N=54) buried in different houses at the site. Using a newly developed imaging technique (Alicona InfiniteFocus 3D measuring microscope), a detailed investigation into the variation in the expression of dental growth disturbances is carried out based on incremental structures (perikymata). Using a range of parameters (number of defects, defect duration, interval between defects, etc.), we compared the pattern of growth disruptions experienced by children buried in history houses (elaborated buildings of long duration) with the pattern experienced by children buried in non-history houses (less elaborated and of shorter duration) at the site. Analysis reveals no significant differences in enamel defect development between children buried in history houses and children buried in non-history houses. We stress the importance of using different defect parameters as well as high-resolution casting and imaging techniques in studies of dental growth disturbances.

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### **Promiscuity or partner preference? Male-female interactions across reproductive states reflect female strategies for avoiding aggression**

EMILY E. BOEHM<sup>1</sup>, ALLISON R. ROGERS<sup>1</sup>, STEFFEN FOERSTER<sup>1</sup>, EMILY E. WROBLEWSKI<sup>2,3</sup> and ANNE E. PUSEY<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Structural Biology, Stanford University School of Medicine, <sup>3</sup>Microbiology and Immunology, Stanford University School of Medicine

The permanent, mixed-sex groups typical of anthropoid primates create opportunities for both cooperation and conflict between the sexes. In chimpanzees (*Pan troglodytes*), fission-fusion

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societies allow individuals flexibility in their overall sociality and preferences for particular social partners. Females' preferences among male partners are likely to shift as they transition between reproductive states. We used long-term records of group composition and other social behaviors from Gombe National Park, Tanzania, to examine dyadic associations between females and males before, during, and after pregnancies of known paternity. Using linear mixed models, we tested two alternative hypotheses: 1) females associate, mate, and groom promiscuously to confuse paternity and avoid infanticide, or 2) females concentrate their relationships on males who are likely to act as protectors during lactation, such as high-ranking males, closely related males, and sires. Using model selection based on Akaike Information Criterion, we found that females have the strongest associations with males before conception and the weakest associations during pregnancy. Pregnant females groom with more aggressive males, but also with high-ranking males and sires. After pregnancy, females continue to groom more with high-ranking males and sires, as well as with more closely related males. Furthermore, lactating females receive less aggression from those males with whom they had groomed before pregnancy and mated during pregnancy. Together, these results suggest that female-male associations can protect against aggression during lactation and that females socialize more with males who are likely to provide this protection.

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### Timing and Duration of Epiphyseal Fusion and Implications for Growth Potential

MELANIE E. BOEYER<sup>1,2</sup>, RICHARD J. SHERWOOD<sup>1,2</sup>, CHELSEA B. DEROCHÉ<sup>3</sup> and DANA L. DUREN<sup>2</sup>

<sup>1</sup>Department of Pathology and Anatomical Sciences, University of Missouri - Columbia, Columbia, MO, <sup>2</sup>Department of Orthopaedic Surgery, Missouri Orthopaedic Institute, University of Missouri - Columbia, Columbia, MO, <sup>3</sup>Department of Health Management and Informatics, University of Missouri - Columbia, Columbia, MO

The hallmark of skeletal maturity is epiphyseal fusion, signaling the end of longitudinal growth. The process of fusion is not instantaneous; its timing and duration can provide vital information related to childhood growth potential and interpretations of significant life history events. To elucidate the relationship between epiphyseal fusion events and a child's growth potential, we assessed serial measurements of height, metacarpal length, and metacarpal fusion, and the timing of the pubertal growth spurt in 528 children from the Fels Longitudinal Study, comprised of healthy children of European descent. Using a

multi-level 2<sup>nd</sup> order polynomial, we compared the relative percentage of final growth in height and metacarpal length with the duration of time spent in a state of active fusion. Children were categorized as "early, normal, or late" maturers based on relative skeletal age at the first sign of epiphyseal fusion.

On average, children reached 93% of their total growth potential in both height and metacarpal length at the beginning of metacarpal fusion and 98% at completion. We found that 74% of children experience their growth spurt *prior* to the beginning of fusion in the metacarpals. Additionally, early maturers spent significantly more time in the process of active fusion and had significantly later ages of final height than early maturers. Using this new model, duration and relative percent of growth remaining can now be predicted for a child given knowledge of their skeletal age status at the first sign of fusion. This represents a significant advance in skeletal growth research.

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### Does National Park Protection influence Mammal Presence?: Comparing Chimpanzee's Competitors, Predators, and Prey between Niokolo-Koba National Park and Fongoli Savanna Research Site in Senegal

STEPHANIE L. BOGART<sup>1</sup>, MALLÉ GUEYE<sup>2</sup>, PAPA IBNOU NDIAYE<sup>3</sup>, JILL D. PRUETZ<sup>4</sup> and STACY M. LINDSHIELD<sup>4,5</sup>

<sup>1</sup>Department of Biological Sciences, University of Southern California, <sup>2</sup>Direction des Parcs Nationaux, Senegal, <sup>3</sup>Department of Animal Biology, Université Cheikh Anta Diop, Senegal, <sup>4</sup>Department of World Languages and Cultures, Iowa State University, <sup>5</sup>Ecology and Evolutionary Biology Graduate Program, Iowa State University

Mount Assirik Research Site (MARS) in Senegal's Niokolo-Koba National Park (NKNP) contains this country's only nationally protected chimpanzees, buffered from anthropogenic disturbance. Thus, research will illuminate referential questions of Plio-Pleistocene environmental impacts on human evolution with many competitors, prey, and predators. At MARS we collected data in July 2015 and January-May 2016. Mammal analyses include the use of camera traps (151 days,  $N=48,883$  photos) and line-transects ( $N=16$ , 1.28km<sup>2</sup>), along with opportunistic and reconnaissance encounters for presence-absence comparisons. Fongoli is situated approximately 62km southeast of MARS and is outside of NKNP. Fongoli mammal data was collected opportunistically from 2001-2014. Comparing the two datasets on presence-absence of mammal species (Fongoli=29/37 and MARS=31/37 present species) indicates no significant

difference (Mann-Whitney  $U=647.5$ ,  $p=0.697$ ), however several species are present exclusively at MARS. Among these species only encountered at MARS include African buffalo (*Syncerus caffer*), Derby's eland (*Taurotragus derbianus*), and armadillo (*Orycteropus afer*). Further, MARS-exclusive predators include lions (*Panthera leo*) and wild hunting dogs (*Lycaon pictus*). While Fongoli's data stems from over 10 years of research, MARS had more Roan antelope (*Hippotragus equinus*) encounters in six-months of research (Fongoli  $N=2$ , MARS  $N=21$ ). These results indicate that chimpanzee interactions with competitor, prey, and predator species differ between the MARS and Fongoli sites due to anthropogenic disturbances. Chimpanzees at MARS may be under more pressure from non-human competitors and predators. MARS offers an opportunity to investigate interspecific competition between chimpanzees and mammal species indicative of a savanna mosaic habitat similar to conditions influencing Plio-Pleistocene hominins.

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### Hidden Heterogeneity in Mortality – Perhaps not so Hidden

JESPER L. BOLDSÉN<sup>1</sup> and GEORGE R. MILNER<sup>2</sup>

<sup>1</sup>ADBOU, University of Southern Denmark, <sup>2</sup>Anthropology, Pennsylvania State University

*The Osteological Paradox* (Wood et al., 1992) – initially criticized, but after 25 years is gaining traction – pointed out serious methodological problems in reconstructing life in the past from observations of archaeological skeletons. The central message concerns our inability to directly infer from the dead the health risks the living experienced from disease, malnutrition, and trauma. That is a problem because perspectives on once-living populations are of interest when characterizing conditions in the past.

The difficulty with mortality (skeletal) samples stems from death being an inherently a selective process because each of us experience different risks of dying. Sometimes such differences can be associated with observable conditions, such as specific recognized diseases, although that is often not the case (i.e., heterogeneity is hidden). Here we present work that exposes hitherto unrecognized heterogeneity, and in so doing point toward a new way to understand the risks experienced by people in the past.

As a by-product of an ongoing project aimed at the generation of accurate and unbiased skeletal age estimates, it has been observed that several age-related skeletal characters show evidence for selective mortality in modern samples. These same skeletal characters were also subject to selective mortality in medieval Danish skeletons,

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showing that they are not solely a feature of modern life.

*This research is derived in part from a National Institute of Justice (USA) project directed by the two authors and Stephen Ousley, with the assistance of Svenja Weise, Peter Tarp and Sara Getz.*

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### Building Bridges: Learning to Use Science and Indigenous Knowledge to Create Productive Partnerships

DEBORAH A. BOLNICK<sup>1,2</sup> and RIPAN S. MALHI<sup>3,4</sup>

<sup>1</sup>Department of Anthropology, University of Texas at Austin, <sup>2</sup>Population Research Center, University of Texas at Austin, <sup>3</sup>Department of Anthropology, University of Illinois, Urbana-Champaign, <sup>4</sup>Carl R. Woese Institute for Genomic Biology, University of Illinois, Urbana-Champaign

Over the last decade, anthropological genetics has been transformed by two key developments: the adoption of new genomic technologies, and increased sensitivity to the views of research participants and communities affected by genetic research. Many graduate programs in biological anthropology have recognized the importance of the technological developments, and have added training in genomic methods and computational analyses of genomic data. However, less pedagogical attention has been given to the ethics training that anthropological geneticists need, especially those who wish to work with indigenous or other marginalized communities. Given that the nature of interactions among researchers, participants, and communities is changing, and more collaborative approaches to study design and data interpretation are becoming expected, it is critical that we train the next generation of anthropological geneticists to take a new approach to research.

In this presentation, we discuss two complementary types of training that are needed to produce future cohorts of anthropological geneticists who are equipped to conduct ethically informed research. First, we discuss the need for anthropological geneticists to become more familiar with bioethics, community-based participatory research, and the legal/social implications of their work. Second, we highlight the importance of training indigenous students to become genome scientists and bioanthropologists themselves, and describe our work with the Summer internship for Indigenous peoples in Genomics (SING) program, which helps provide such training. We illustrate the benefits of these approaches with examples from our collaborations with indigenous peoples, and show how partnerships that bring science and indigenous knowledge together yield better science.

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### Muscle proportions and body composition in an infant gorilla

DEBRA BOLTER<sup>1,2</sup>, CAROL UNDERWOOD<sup>3</sup> and ADRIENNE ZIHLMAN<sup>3</sup>

<sup>1</sup>Anthropology, Modesto College, California,

<sup>2</sup>Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa,

<sup>3</sup>Anthropology, University of California, Santa Cruz

During the process of growth, hard tissues like teeth and bones are most often the focus of study. They record markers of life history, for example, eruption of the first permanent molar to mark the juvenile stage, or complete eruption with fusion of humeral head to denote the adult stage. As body mass is added, particularly muscle, and size increases, body dimensions and tissue proportions also transform from infant through adult, and many of the changes relate to locomotor development.

The accidental death of a 16 month-old captive female provided opportunity to study body composition in a healthy infant. At death she weighed 10.5 kg, all of her deciduous dentition were erupted, and no long bones fused. We dissected and measured limb and segment proportions, and separated muscle, bone, skin tissues, analyzed the data and compared them to those of an adult female gorilla dissected using the same methods (Zihlman & McFarland 2000).

The infant had less muscle but more bone compared to the adult (34.4% and 18.3% vs. 38.0% and 13.4%) and relatively heavier forelimbs and hindlimbs relative to body mass (16.3%, 19.9% vs adult: 13.6%, 17.5%). Together the limbs comprised 36.2% of body mass compared to the adult's at 31.1%. Within the limb segments the infant's hands and feet were relatively twice as heavy as the adult. The distribution of body mass to the limbs, particularly to the hands and feet, indicate that the infant was in the process of acquiring the structural underpinnings of skilled locomotor behavior.

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### Lost and Found: Forgotten Cemeteries Under the City of Milwaukee

SARAH A. BONCAL

Anthropology, University of Wisconsin Milwaukee

As cities developed over the centuries, copious cemeteries were forgotten, lost and/or enveloped by urban expansion. Historical records, while informative, repeatedly failed to mark cemeteries on early maps. Correspondingly, many cemeteries were relocated in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries as urban areas spread out. Prompted by the excavation of multiple cemeteries related to the Milwaukee County Institution Grounds Poor Farm in 1991 and 2013, a GIS study was undertaken to ascertain how many cemeteries might still remain under the greater city of Milwaukee. A series of historical plat maps were georeferenced and overlaid with recorded cemetery sites

identified from the Wisconsin Archaeological Sites Inventory. According to the results, there are at least 21 possible cemeteries that might remain under the city limits. This number could escalate as more maps are included, providing useful information for CRM archaeologists and historical preservation as urban expansion and construction continues.

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### Sexual dimorphism of the humerus in a Japanese sample: A test of the İşcan et al. (1998) method

ROSANNE BONGIOVANNI and CARRIE B. LEGARDE  
Anthropology, University of South Florida

Metric sex estimation is often utilized in bioarchaeological and forensic settings, and population-specific formulae have been suggested to achieve optimal results. The purpose of this study is to validate the accuracy of formulae generated by İşcan et al. (1998) with data from a different Japanese sample: the Chiba skeletal collection. The following standard measurements of the humerus were utilized: maximum length, epicondylar breadth, vertical head diameter, and minimum and maximum midshaft diameter. Each measurement was compared between the two studies utilizing a Student's t-test and no significant differences were found ( $p > 0.05$ ). Formulae 2, 5, and 7 from İşcan et al.'s study were utilized in this study. Formula 2, a discriminant function, yielded the best overall accuracy (94%), while the univariate indices for the vertical head diameter (Formula 5) and epicondylar breadth (Formula 7) were only slightly lower: 90% and 92%, respectively. Overall, the accuracy for the female group was better than the males with rates ranging from 94-100% and 85-92%, respectively. In addition to standard measurements, the capitulum-trochlea breadth of the humerus was also tested as an index on the current sample. A sectioning point of 40.9 mm yielded an overall accuracy rate of 93% with the male and female accuracy rates performing almost equally (94% and 93%, respectively). This study confirms that the formulae proposed by İşcan and colleagues are reliable measures for use on Japanese samples, and proposes the capitulum-trochlea breadth be added as an additional technique with which to reliably estimate sex.

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### The middle Pleistocene human pelvis: a comparison across Eurasia

ALEJANDRO BONMATÍ<sup>1,2</sup>, KAREN ROSENBERG<sup>3</sup>, JUAN LUIS ARSUGA<sup>1,2</sup> and LÜ ZUNÉ<sup>4</sup>

<sup>1</sup>Department of Palaeontology, Facultad de Ciencias Geológicas, Complutense University, Spain,

<sup>2</sup>Department of Human Evolution, Centro UCM-ISCIII de Evolución Humana, Spain, <sup>3</sup>Department of Anthropology, University of Delaware, USA,

<sup>4</sup>Department of Archaeology, Peking University, China

## ABSTRACTS

A significant number of human pelvic remains have been published since the first fossil hip bone attributed to the genus *Homo* was discovered in the Neander Valley. However, there are still important gaps in the fossil record. Only three Eurasian middle Pleistocene remains are well enough preserved for comparative purposes: the virtually complete pelvis from Sima de los Huesos site in Spain (SH Pelvis 1), the quite complete hip bone from the Chinese cave of Jinniushan and the partially complete hip bone from the French cave of Arago (Arago 44). In the present study we make a direct comparison between Jinniushan and SH Pelvis 1 for the first time taking advantage of CT scans of the original fossils.

The overall morphology of SH Pelvis 1 and Jinniushan is very similar. These two specimens are both very large overall. They retain the pelvic breadth seen in earlier, smaller bodied humans. Most differences between them can be explained as the result of sexual dimorphism. In particular, we think that these two specimens can be attributed to a male (SH Pelvis 1) and female (Jinniushan) individual due to differences in pubic and sciatic notch morphology, however they closely match each other in size. The similarity in pelvic morphology that we see across the Eurasian continent suggests that middle Pleistocene hominins shared a broad pelvis similar to their lower and middle Pleistocene ancestors (e.g. KNMER 3228 and OH28) but scaled up to a larger body size.

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### Morphometric analysis of the chimpanzee maxillary and ethmoid sinuses

SETH B. BOREN<sup>1</sup> and DIANA DURAND<sup>2</sup>

<sup>1</sup>Department of Scientific Computing, Florida State University, <sup>2</sup>Department of Anthropology, University of Arkansas

The paranasal sinuses are a relatively unexamined region of the primate skull. As such, a morphometric study of the sinuses can potentially yield new information on morphological variation between individuals of the same species. The following analysis tests to see if significant differences exist between chimpanzees in the morphology of the maxillary and ethmoid sinuses. All of the sampled chimpanzee skulls were mapped for thirty landmarks present in the maxillary and ethmoid sinuses and subjected to a principal component analysis (PCA). The first three components of the PCA were then subjected to an analysis of variance (ANOVA) to see if a significant amount of variance existed between chimpanzees. No significant differences were found between chimpanzees grouped by sex and locality, but significant differences were

found between chimpanzees when grouped by collection period. A greater samples of chimpanzee skulls with intact paranasal sinuses will be needed to further investigate how the observed significance differences came about. An analysis with a larger sample of species may lead to a greater understanding of variation in the overall paranasal sinus amongst great apes.

### A geometric morphometric analysis of pollical metacarpal shaft morphology in Gorilla, Pan, and Homo

LUCYNA A. BOWLAND<sup>1</sup>, JILL E. SCOTT<sup>2,3</sup>, BIREN A. PATEL<sup>4</sup>, MATTHEW W. TOCHERI<sup>5,6</sup> and CALEY M. ORR<sup>7</sup>

<sup>1</sup>Department of Anthropology, University of Colorado Denver, <sup>2</sup>Department of Sociology and Anthropology, Metropolitan State University of Denver, <sup>3</sup>Department of Anthropology, University of Iowa, <sup>4</sup>Department of Cell and Neurobiology, Keck School of Medicine, University of Southern California, <sup>5</sup>Department of Anthropology, Lakehead University, <sup>6</sup>Human Origins Program, National Museum of Natural History, Smithsonian Institution, <sup>7</sup>Department of Cell and Developmental Biology, University of Colorado School of Medicine

A robust thumb capable of powerful precision grasping is typically recognized as a shared, derived character trait of later hominins. However, tracing the evolution of this character and inferring the manipulative capabilities of fossil hominins requires an accurate quantification of thumb morphological differences among species. Here, we present preliminary results of a 3D geometric morphometric analysis of the pollical metacarpal (Mc1) from an adult sample of modern humans and African apes. Our aim is to quantify variation in aspects of hominid Mc1 shaft morphology relating to muscle entheses development (opponens pollicis and first dorsal interosseous) and overall robusticity. Nine landmarks were placed on 3D virtual renderings (derived from laser, CT, and  $\mu$ CT scans) along the palmar shaft and a 20 x 20 semilandmark grid was placed across the palmar diaphyseal surface. The 3D semilandmark data were subjected to a principal components analysis (PCA) of Procrustes shape variables. The results demonstrate significant variation within and between species in their muscle-attachment cresting and shaft breadth, with taxa forming distinct clusters in the PCA. These results indicate that the dataset analyzed here can provide a useful quantitative framework for describing and analyzing thumb morphology. Moreover, the quantified shape differences have important functional implications and will be useful for understanding the evolution of the fully opposable thumb and powerful precision grasping that facilitate tool manufacture and use in *Homo sapiens* and fossil hominins.

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### Approaching studies of multiple traumata from the leg up: An examination of the effect of prior injury location on patterns of subsequent injury in 18<sup>th</sup> and 19<sup>th</sup> century London

DEREK A. BOYD<sup>1</sup> and COLLEEN F. MILLIGAN<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Tennessee, Knoxville, <sup>2</sup>Department of Anthropology, California State University, Chico

Injuries are thought to be but one of many biological outcomes of the interaction between individuals and their environments. Susceptibility to injury is dependent upon a myriad of factors, including previous injury. Recent studies have suggested that the location of a prior injury may also play an important role in risk of future injury. The objective of this study was to examine the impact, if any, that prior injury to different regions of the skeleton had on patterns of subsequent injury in Industrial-era London (AD 1700-1850). The skeletal remains of 46 adults from the parishes of St. Bride (n=33) and Chelsea (n=13) were examined for evidence of fractures to the head, trunk, arm, and leg. Individuals with multiple fractures were considered to exhibit evidence of subsequent injury if they presented at least one antemortem and one perimortem fracture. Assessment of subsequent injury was precluded by the absence of perimortem fractures in both parishes, which suggests that fracture treatment was accessible to individuals regardless of socio-economic status. Of interest, however, is that individuals from the urban poor parish of St. Bride were more likely to present fractures to the leg than individuals from the affluent rural parish of Chelsea (OR=5.84, 95% CI: 1.18-30.55). The findings of this study underscore the importance of considering the timing of injuries in studies of injury recidivism, and reiterate the importance of the careful construction of archaeological samples.

### Evidence for grooming claws in the earliest omomyids

DOUG M. BOYER<sup>1</sup>, STEPHANIE A. MAIOLINO<sup>2,3</sup>, PATRICIA A. HOLROYD<sup>4</sup>, PAUL E. MORSE<sup>5,6</sup> and JONATHAN I. BLOCH<sup>6</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine, <sup>3</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, <sup>4</sup>Museum of Paleontology, University of California, Berkeley, <sup>5</sup>Department of Anthropology, University of Florida, Gainesville, <sup>6</sup>Florida Museum of Natural History, University of Florida, Gainesville

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The physical appearance and behavior of the ancestor of living primates remains poorly constrained in many respects due to a lack of evidence on early fossil taxa. One feature that exhibits functionally and phylogenetically significant variation among modern primates is the form of the distal phalanx on the second pedal digit. Modern strepsirrhines and tarsiers exhibit a "grooming claw", while all anthropoids except *Aotus* have a typical nail. Though at least two fossil adapiforms (the earliest known potential strepsirrhines) have been shown to have grooming claws, the question of whether the ancestral euprimate had a grooming claw has remained inconclusive due to a lack of information on this anatomy in fossil omomyiforms (the earliest known haplorhines). We now report the recovery of isolated distal phalanges from three early Eocene localities in Wyoming and present multiple lines of quantitative and qualitative, comparative evidence revealing that these bones most closely resemble those of the second pedal digit of extant prosimians. We therefore conclude that they represent grooming claws of primates. Based on the absolute size of these bones and faunal composition of their localities, we further conclude that at least four genera of omomyiforms sported a grooming claw. One of these grooming claws is contemporaneous with and attributed to the earliest known euprimate in North America, *Teilhardina brandti*. These new data on the phylogenetic distribution and antiquity of primate grooming claws strongly suggests that a grooming claw was present in the ancestral euprimate

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### A Macroevolutionary Perspective on Human Gut Proportions

EVE K. BOYLE<sup>1</sup> and SERGIO ALMÉCJA<sup>1,2</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>2</sup>Institut Català de Paleontologia Miquel Crusafont (ICP)

Gut proportions (GP) are assumed to reflect both phylogeny and the type of diet a species is best adapted to digest. Though data suggest that humans are unique among hominoids in having a relatively large small intestine and a relatively small colon, there is no consensus on what this reveals about human dietary evolution. Conflicting interpretations of the same data argue that human GP reflect adaptations to a carnivorous, omnivorous, frugivorous, or most recently, a 'cucinivorous' diet. To shed light on this matter, we use available data on mammalian gut organ surface area (stomach, small intestine, caecum and colon) and body weight to test instances of convergence with human GP in a macroevolutionary framework.

'Extrinsic' GP (i.e., each organ surface area relative to body weight) were calculated in a sample of 164 adult individuals representing 58 wild and 6 domestic species. These were incorporated in a multi-regime Ornstein-Uhlenbeck (OU) model, revealing a single convergent evolutionary regime. Species under this regime include humans, the *Cebus-Saimiri* clade, most carnivores in the sample, cetaceans, and *Potamogale velox* (the giant otter shrew). All these species are characterized by a relatively small caecum and colon, suggesting that human extrinsic GP have evolved away from a generalized primate pattern characterized by a greater reliance on the hindgut for digestion. These results do not support the hypothesis that human GP are similar to those of an unspecialized frugivore. Future analyses will incorporate other physiologically relevant variables to better resolve the above debate.

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### Pigmentation in a Comparative Context: Factors Shaping Variation and Convergence in Primate Pelage Patterns

BRENDA J. BRADLEY<sup>1</sup>, JASON M. KAMILAR<sup>2</sup>, AMANDA N. SPRIGGS<sup>1,3</sup>, BENJAMIN C. WILHELM<sup>1,3</sup> and SUSAN WALSH<sup>4</sup>

<sup>1</sup>Center for the Advanced Study of Human Biology, Department of Anthropology, The George Washington University, <sup>2</sup>Department of Anthropology, University of Massachusetts Amherst, <sup>3</sup>Department of Anthropology, University of Albany, <sup>4</sup>Department of Biology, Indiana University - Purdue University Indianapolis

Human pigmentation varies spatially and temporally across populations, across body regions, and across cell types (skin and hair). Some aspects of pigmentation seem unique to humans (e.g. tanning) but others show marked phenotypic convergence with other primates (e.g. freckled/mottled skin, red hair phenotypes, ontogenetic changes in melanism). Thus, a phylogenetic comparative framework can inform our understanding of the evolutionary and environmental factors that shape pigment variation in humans. With a particular focus on pelage, we measured patterning and coloration for >150 primate species (multiple individuals of both sexes) representing all major clades. Phenotypic data were generated via multiple methods including microscopy of pigment packaging, spectrophotometry, and digital photography. Comparative analyses indicate that pelage luminance is associated with aspects of the environment (e.g. humidity), but dark coloration is not necessarily synonymous with increased melanism. For example, our results indicate that 'darker' and 'lighter' phenotypes can be generated, not only by altering pigment type and content, but also

by modifying the structure of the medulla. To examine the molecular bases of pelage variation, we also measured gene expression in hair follicles of differing pigment phenotypes via RNAseq and qRT-PCR for a subset of primate species. Our preliminary results indicate that many of the same genes involved in mediating pigmentation in humans and other mammals (e.g. *KITLG*, *PMEL*) also underlie color variation and patterning in non-human primates.

### Rank Differences in Male Bonobo (*Pan paniscus*) Reproductive Strategies

COLIN M. BRAND, ALEXANA J. HICKMOTT, KLAREE J. BOOSE and FRANCES J. WHITE  
Anthropology, University of Oregon

Bonobos exhibit male philopatry without male dominance. This uncommon social structure results in communities where younger males can reside with their mothers. If those mothers are high ranking, they can affect their son's reproductive success. We collected focal and interaction data over 242 hours on three bonobo communities at the N'dele site in the Lomako Forest, DRC. Here, we compared the success of the top ranking adult male and two lower ranking adult males in maintaining proximity and mating with potentially fertile versus non-fertile female bonobos in the Bakumba community. There were two adult females with maximal swellings during the period of focal sampling. The males differed significantly in their proximity maintenance with these females (Test of Independence  $G = 18.769$ ,  $P < 0.001$ ), with the top-ranking male spending 80% and the two males only averaging 3.1% with the fertile females. The two lower ranking males were not significantly different in their proximity frequency with non-fertile females (Non-significant subset  $G = 1.356$ , ns). Both lower ranking males maintained frequent proximity with different old, post-menopausal, low-ranking females possibly their mothers. The dominant male mated successfully with at least one fertile female. One subordinate male attempted to mate with this female but was aggressively interrupted by the dominant male. Male dominance in bonobos, therefore, is correlated with both proximity and mating with fertile females, and suggests that the advantages of association with mothers for adult males is strongly influenced by the rank of those mothers.

### Does the Energetic Status of Wild Orangutan Mothers vary with Infant Age?

TIMOTHY D. BRANSFORD<sup>1,2</sup>, MELISSA EMERY THOMPSON<sup>3</sup>, DANIEL J. NAUMENKO<sup>1,2</sup>, ALYSSE M. MOLDAWER<sup>1,2</sup>, ALEXANDER J. PRITCHARD<sup>1,2</sup>, MARIA A. VAN NOORDWIJK<sup>4</sup>, SRI SUCI UTAMI ATMOKO<sup>5</sup> and ERIN R. VOGEL<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, Rutgers University, <sup>2</sup>Center for Human Evolutionary Studies, Rutgers University, <sup>3</sup>Department of Anthropology, University

## ABSTRACTS

of New Mexico, <sup>4</sup>Anthropologisches Institut und Museum, Universität Zürich, <sup>5</sup>Faculty of Biology and Primate Research Center, Universitas Nasional

Female Bornean orangutans (*Pongo pygmaeus wurmbii*) nurse their infants for up to eight years, spanning multiple periods of unpredictable fruit availability. During extended periods of fruit scarcity, it may be hard for mothers to meet the energetic costs of lactation and infant carrying. Yet we do not know if a mother's energetic status varies during her extended nursing period. To examine this, we collected behavioral data and urine samples from seven females with infants of different ages during nest-to-nest focal follows in the Tuanan Research Station area (2009-2013). We examined if energetic status, quantified by radioimmunoassay of urinary C-peptide of insulin and ketone presence (an indicator of fat catabolism) measured with urine test strips, was related to the age of her infant, after controlling for individual ID. We did not find a significant relationship between a mother's urinary C-peptide values and her infant's age ( $p=0.44$ ). We also did not find a significant relationship between the presence of ketones and infant age ( $p=0.11$ ). However, we did find a significant relationship between the presence of ketones and both fruit availability ( $p=0.03$ ) and daily protein intake ( $p=0.01$ ). These results suggest that orangutans have adaptations to maintain a neutral energetic balance throughout most of their nursing period, and utilize fat reserves for energy when protein intake is highest and caloric intake is reduced. Thus, mother orangutans are adapted to these unpredictable episodes of fruit scarcity and use a flexible foraging strategy to avoid negative energy balance states throughout much of the lactation period.

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### Recovery of ancient DNA from Upper Nubian skeletal remains

ABAGAIL M. BREIDENSTEIN<sup>1,2</sup>, ABIGAIL BOUWMAN<sup>2</sup>, GRETCHEN E. ZOELLER<sup>3</sup>, GEOFF EMBERLING<sup>4</sup>, FRANK RUEHLI<sup>2</sup> and ABIGAIL W. BIGHAM<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Michigan, <sup>2</sup>Institute of Evolutionary Medicine, University of Zurich, <sup>3</sup>Department of Anthropology, Indiana University, <sup>4</sup>Kelsey Museum of Archaeology, University of Michigan

The use of ancient samples from the Nile River Valley for anthropological genetic studies has proven difficult due to adverse conditions for preservation of biomolecules like DNA. Recent advances in recovery methodologies of ancient biomolecules, however, have allowed for the exploration of populations in this region previously not included, namely Upper Nubians (modern Sudan). For this study, we attempted to recover ancient DNA (aDNA) from a sample of Medieval

Nubians, excavated from the Christian settlement site of el-Kurru. Skeletons of twenty-six individuals were exhumed from the adjacent cemetery using sterile techniques during recovery and post-field processing. aDNA was extracted and amplified using previously optimized protocols in a clean room setting. Initial results show human DNA is recoverable, despite poor preservation of the skeletal tissue and teeth due to thermal degradation in this climate and repeated inundations over many centuries at el-Kurru. These results demonstrate the potential to explore further the genetic history of Nubia by including populations from the region of Upper Nubia, thus expanding the use of aDNA throughout the ancient Nile Valley. With its rich and expansive history, the ability to examine the genetic makeup of the Nile Valley in a fuller capacity will undoubtedly provide valuable information allowing for an even deeper and more comprehensive understanding of this region for future research.

### Make no bones without it: Characterization of region-specific behaviors in non-sutural cranial osteoblasts using bone morphogenetic proteins

JUSTIN A. BRILL<sup>1</sup>, HOLLY E. WEISS-BILKA<sup>1</sup> and MATTHEW J. RAVOSA<sup>1,2,3</sup>

<sup>1</sup>Department of Biological Sciences, University of Notre Dame, <sup>2</sup>Department of Aerospace and Mechanical Engineering, University of Notre Dame, <sup>3</sup>Department of Anthropology, University of Notre Dame

Flexion of the basicranium is thought to be a consequence of encephalization. While the basicranium serves as a key architectural interface between the developing brain and face, basicranial osteoblast (BoB) behavior has yet to be investigated. Characterizing basicranial development vis-à-vis cytokine signaling pathways, such as bone morphogenetic proteins (BMPs) will help elucidate targets of selection on hard-tissue formation during primate and hominid evolution. Interestingly, BoBs do not respond to traditional osteogenic induction in culture. Perhaps this is because the basicranium forms endochondrally, which contrasts with other cranial elements that ossify intramembranously. Thus, BMP6 was chosen as an induction cytokine due to its presence in mineralizing cartilage during development. Primary BoBs were isolated from neonatal mice, then high-density micromasses were formed to mimic the *in vivo* cellular microenvironment. Micromasses ( $n=3$ ) were treated for 4–6 weeks using osteogenic media with (treatment) or without (control) 100 ng/mL BMP6. Genetic analysis via qRT-PCR demonstrated significant ( $p<0.05$ ) increases in the expression of hypertrophic and osteogenic markers with BMP6 treatment vs. controls. Similarly, histological staining revealed a proteoglycan-rich cartilaginous tissue at 4 weeks that was largely replaced

by calcium-rich mineralized tissue by 6 weeks of BMP6 treatment. These findings identified BMP6 as a potent inducer of BoB mineralization via the native endochondral pathway, which indicates it may play a key role in basicranial development. Ongoing experiments to determine the specificity of BMP6 to bone formation in the basicranium vs. other craniomandibular sites suggest that ossification mode may be a critical ontogenetic determinant of oB behavior.

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### Genomic basis for fatal *Toxoplasma gondii* infection in primates

YARAVI SUAREZ<sup>1</sup>, SUVANTHEE GUNASEKERA<sup>1</sup>, NEGIN VALIZADEGAN<sup>1</sup>, KATHERINE VAN ETTEN<sup>1</sup>, WILLIAM H. WITOLA<sup>2</sup>, JÖRG LINDE<sup>3</sup> and JESSICA F. BRINKWORTH<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Illinois Urbana-Champaign, <sup>2</sup>Department of Pathobiology, College of Veterinary Medicine, University of Illinois Urbana-Champaign, <sup>3</sup>Systems Biology and Bioinformatics, Leibniz Institute for Natural Product Research and Infection Biology, Hans-Knöll-Institute

*Toxoplasma gondii* is a widespread, obligate intracellular parasite famous for inducing miscarriage in pregnant women, lethal infection in immunocompromised humans and behavioral irregularities in rodents. In most healthy, adult mammals *T. gondii* typically manifests as an asymptomatic, lifelong infection. In animals that lack an extensive evolutionary history with the parasite's definitive host (most felines), *T. gondii* tends to generate swift and fatal necrotizing infections. In New World monkeys and Malagasy lemurs death can occur within a week of infection and mortality rates of some species near 100%. As the parasite commonly contaminates food, is readily transmitted by rodents and cats, and can persist in the environment for years, *T. gondii* infection presents a challenge for both human health and primate care. Monocytes play an important role in control of the parasite. To assess why some primates suffer severe infections, while others control *T. gondii*, we infected monocytes from healthy animals that develop lifelong (humans, olive baboons, rhesus macaques) and severe (common marmosets, ring-tailed lemurs) infections, with *Toxoplasma gondii* RH for 12 and 24 hours. We assessed cell parasite load, cell death and whole genome expression. Monocytes from the "severe" group maintain higher parasite loads and die at a higher rate. We noted inter-species differences in gene expression across multiple gene families, including genes involved in inflammation, and in pathway regulation in response to *Toxoplasma*. These observations suggest that primate monocyte function has diverged and that these changes contribute to inter-species differences in *Toxoplasma* lethality.

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### Crossing Structure Design and Effectiveness for Primate Conservation

INDIA J. BROCK, LESLIE E. GOTUACO, COLIN M. BRAND, ULRIKE S. STREICHER and LARRY R. ULIBARRI

Department of Anthropology, University of Oregon

Habitat fragmentation is an increasing problem for wildlife populations, including primates. Infrastructure, such as roads, can dissect primate habitats into fragments, separating populations. There are publications on habitat fragmentation and on the methods used to reconnect habitat patches, but there is a near absence of literature on the specific use of canopy bridges to aid the movement of primates. The objective of this review is to gather published data so that we may apply it in the development of suitable road-crossing structures for primates both in the wild and improve crossing structures in captivity. This study synthesizes published data on the design and effectiveness of crossing structures across various primate taxa including two studies on strepsirrhines, five on New World monkeys, two on Old World monkeys, and five on apes. The literature highlights overall success with these structures, however, we argue that these results may be biased as less successful trials are usually not published. In order to effectively conserve primate populations the results of both successful and unsuccessful trials need to be published. And although structure material, length, and bridge access are major factors influencing the effectiveness of crossing structures, our review highlights the need for species specificity in their design. We encourage the publication of both captive and wild studies on the effectiveness of crossing structures. Limited conservation resources highlight the utility and necessity of captive studies to contribute to the development of crossing structures and reduce costly trials in a wild setting.

### A morphometric assessment of *Homo naledi* deciduous molar teeth from Dinaledi Chamber, Rising Star cave system, South Africa

JULIET K. BROPHY<sup>1,2</sup>, SHARA E. BAILEY<sup>3,4</sup>, JACOPO MOGGI-CECCHI<sup>5</sup>, LUCAS K. DELEZENE<sup>2,6</sup>, MATTHEW SKINNER<sup>2,4,7</sup> and DARRYL J. DE RUITER<sup>2,8</sup>

<sup>1</sup>Geography and Anthropology, Louisiana State University, <sup>2</sup>Evolutionary Studies Institute and Centre for Excellence in PaleoSciences, University of the Witwatersrand, <sup>3</sup>Center for the Study of Human Origins, New York University, <sup>4</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>5</sup>Laboratori di Antropologia, Università degli Studi di Firenze, <sup>6</sup>Department of Anthropology, University of Arkansas, <sup>7</sup>School of Anthropology and Conservation, University of Kent, <sup>8</sup>Department of Anthropology, Texas A&M University

Fossil teeth play an important role in diagnosing and examining taxonomic differences in hominin

species and factor strongly in discussions on the origins of the genus *Homo*. Less attention has been paid to deciduous teeth despite the fact that they are considered more conservative in their morphology compared to their permanent counterparts. This study uses elliptical Fourier analysis to investigate the crown shape of the  $dm^1$ ,  $dm^2$ ,  $dm_1$ , and  $dm_2$  of a sample of hominin teeth from the Plio-Pleistocene. The goal is to document the deciduous teeth of *Homo naledi* from the Dinaledi Chamber, South Africa, and to establish similarities/differences among hominins. The Dinaledi fossils were compared with deciduous molar teeth from hominins classified as *Australopithecus africanus*, *A. afarensis*, *A. sediba*, *Paranthropus robustus*, *P. boisei*, *Homo sp.*, *H. erectus*, early *H. sapiens*, Upper Paleolithic *H. sapiens*, recent *H. sapiens*, and Neandertals. Principal component analyses were performed on the amplitudes of the digitized teeth. The results indicate that the  $dm^2$  overlaps the most with early and recent *H. sapiens* while the  $dm_2$  falls within the range of *P. robustus*. The trapezoidal outline of the  $dm^1$  is most similar to Neandertals. The  $dm_1$ , however, is unique in its morphology when compared to the current sample due to its buccolingually narrow shape. The *H. naledi* teeth do not consistently align with any species in the comparative sample.

### A numerical scoring system for estimation of age-at-death via visual analysis of the pubic symphysis, modelled after the Brooks & Suchey (1990) phasing method, using a Thai population

ALICE E. BROWN<sup>1</sup> and PASUK MAHAKKANUKRAUH<sup>2</sup>

<sup>1</sup>Science and Social Science, Peterborough Regional College, <sup>2</sup>Department of Anatomy, Chiang Mai University

The pubic symphysis is the most commonly used degenerative indicator for adult age-at-death estimation from the skeleton. In current methodologies, the pubic symphysis is visually assessed based on largely predictable morphological changes which correspond with chronological age. However, issues with frequently used methods are many and varied. The Brooks & Suchey (1990) method specifically has been criticised for wide age ranges, high inter- and intra-observer error, sample size and population specificity.

During research, ten features, all of which are mentioned by Brooks & Suchey (1990) were used and a hierarchy of scores for each feature developed. Weights were applied to each feature based on its "strength" and reliability as an indicator of age-at-death. This numerical scoring method was developed using a Thai population ( $n=486$ ) and tested using the same population ( $n=252$ ). Descriptors were used to assign and phase according to Brooks & Suchey (1990), then

scores, and a total weighted score, was determined using the new numerical method.

Both males and females showed a very strong linear relationship; this led to the decision to use inverse prediction to develop a series of 95% age-at-death ranges based on weighted scores.

Following the testing of the numerical method against both Brooks & Suchey (1990) methods (95% ranges and mean age  $\pm$  SD for the relevant phase), it was determined that the numerical method had an accuracy of 91.3%, vs. accuracies of 78.8% and 36.4% for Brooks & Suchey (1990)'s 95% ranges and mean  $\pm$  SD ranges respectively ( $n=252$ ).

### Arsenic fed piglets: Assessing arsenic levels in decomposing pig tissue and soil samples

COURTNEY L. BROWN and ROBERT R. PAINE  
Forensic Sciences, Texas Tech University

This study develops expectations for assessing arsenic levels in pig tissue as it decomposes. There are several methods available for the assessment of arsenic. However, when one considers examining decomposing human tissue these tests are limited in arsenic detection. Furthermore, how arsenic degrades during decomposition is poorly understood, knowing this would help to assess acute-toxic antemortem dosages leading to death. Arsenic (potassium arsenate) was fed to 4 piglets at a sub-lethal concentration for a 3 day period. The piglets received 2.8 mg/kg of arsenic. Care of the pigs during arsenic feeding was done in accordance with Texas Tech University IUCAC procedures. Two additional piglets act as a control sample, and were not fed arsenic. After the fourth day they were euthanized and the 6 piglets were then placed for surface decomposition. Soil samples were taken before placement of the pigs and act as control samples. Tissue samples were taken from the pigs before they were set out. Additional tissues samples are taken after days ten, seventeen, thirty, sixty-six, and ninety. Soil and tissue samples show high levels of arsenic concentrations. Pre-carcass decomposition soil samples averaged 1.69 ppm of arsenic. The average amount of arsenic found in the soils on day ten was 2.57 ppm. There was no significant change in the arsenic concentrations from the soil under the control pigs. Tissue samples at day ten show a range of 0.017-0.0648 ppm. In conclusion, this project provides an assessment for expectations of arsenic concentrations in decomposing tissues and soil samples.

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### Relations of hot flash severity, stress and socioeconomic status among Mayan and non-Mayan women in Campeche, Mexico

DANIEL E. BROWN<sup>1</sup>, LYNNETTE L. SIEVERT<sup>2</sup>, LAURA HUICOCHEA GOMEZ<sup>3</sup> and DIANA CAHUICH CAMPOS<sup>3</sup>

<sup>1</sup>Anthropology, University of Hawaii at Hilo,

<sup>2</sup>Anthropology, University of Massachusetts at Amherst, <sup>3</sup>Division of Society y Culture, ECOSUR Unidad Campeche, Mexico

Reports suggest psychosocial stress may invoke hot flashes. In a study of women at midlife residing in Campeche, Mexico, Maya and non-Maya participants were asked about the severity of hot flashes, completed the Perceived Stress Survey (PSS), had height and weight measured, provided information about socioeconomic status (SES) and education, and provided finger-stick blood samples for measurement of C-reactive protein (CRP) and Epstein-Barr virus antibodies (EBV). The blood samples were assayed using commercial ELIZA kits. No CRP values were over 10 mg/L that would indicate an acute inflammatory response, and all participants were EBV positive.

PSS score was significantly correlated with hot flash intensity ( $n=305$ ,  $p=0.17$ ,  $p<0.01$ ; Spearman correlations) and education ( $r=0.18$ ,  $p < 0.01$ ), while EBV value was not significantly correlated with these variables nor with PSS score ( $n=114$ ,  $r=-0.06$ , ns). In a regression model using backwards elimination with hot flash intensity as the dependent variable and EBV, PSS score, SES, education, BMI and age as predictor variables, PSS score ( $\beta=0.22$ ,  $p < 0.05$ ), EBV value ( $\beta=-0.18$ ,  $p < 0.05$ ) and SES ( $\beta=-0.16$ ,  $p < 0.1$ ) remained in the model. When the regressions were run separately for women of Mayan or non-Mayan ethnicity, respectively, for Maya, PSS score ( $r=0.31$ ,  $p < 0.05$ ) and SES ( $r=-0.20$ ,  $p < 0.1$ ) remained in the model; for non-Maya women, only EBV values ( $\beta=-0.33$ ,  $p < 0.05$ ) remained in the model.

These results suggest an ethnic difference in the relation between stress and hot flash intensity among these women.

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### Use of the structured light scanner David SLS-2 for recording auricular surface in 3D and implications for age at death assessment

JAROSLAV BRŮŽEK<sup>1</sup>, JÁN DUPEJ<sup>1,2</sup>, ANEŽKA KOTĚROVÁ<sup>1</sup>, REBEKA RMOUŠILOVÁ<sup>1</sup> and JANA VELEMÍNSKÁ<sup>1</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>2</sup>Department of Software and Computer Science Education, Faculty of Mathematics and Physics, Charles University

Estimation of age at death by skeleton is complicated by errors that may arise from subjective evaluation of senescence related changes.

This subjectivity can be mitigated with the use of three-dimensional imaging and mathematical evaluation of the data. Surface scanners allow for very precise and objective capture of bone surfaces; furthermore, their portability and affordability make them useful tools both on site and in a laboratory.

The aim of this contribution is to capture the auricular surface on a small sample of pelvic bones ( $N=28$ ) with the portable scanner David SLS-2 and to use methods of geometric morphometrics to describe the structural variability of the surfaces. We calculate Gaussian curvature in each vertex of the studied surface and use the distribution of curvature to estimate age at death with machine learning algorithms (support vector machines). Multivariate statistics are used to validate the differences in surface curvature distribution among age groups.

The distribution of surface curvature is known to relate with age at death. Therefore, modern data mining techniques can be used to learn the patterns of senescence-related changes to the auricular surface and to predict age at death. Also, the scanner David SLS-2 is shown to be adequate for capturing the auricular surface for such purposes. Further perspectives of this research are discussed.

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### Nutritional Strategies of Female Redtail Monkeys (*Cercopithecus Ascanius*)

MARGARET A. H. BRYER<sup>1,2</sup>, DAVID RAUBENHEIMER<sup>3</sup> and JESSICA M. ROTHMAN<sup>1,2,4</sup>

<sup>1</sup>Anthropology Program, The Graduate Center of the City University of New York, <sup>2</sup>New York Consortium in Evolutionary Primatology, <sup>3</sup>Charles Perkins Centre and School of Life and Environmental Sciences, University of Sydney, <sup>4</sup>Anthropology, Hunter College of the City University of New York

Primates interact with complex foraging environments to assemble diets from available foods to meet their nutritional needs, which change, for example, with reproduction. Redtail monkeys (*Cercopithecus ascanius*) are small-bodied guenons that are surprisingly flexible feeders, switching between a variety of food types and species. Given redtail monkeys' reliance on fruits while also exploiting a variety of foods secondarily, we predicted that cycling females within and across groups would maintain a ratio of non-protein energy (NPE) to available protein (AP) that would place their nutritional strategy between what has previously been found for frugivorous spider monkeys and omnivorous baboons. We conducted full-day focal follows ( $n=96$ ) on adult females ( $n=24$ ) in three groups in Kibale National Park, Uganda and conducted nutritional analyses of >402 food samples with wet chemistry analyses and near-infrared spectroscopy. Plant

reproductive parts contained a mean of  $40.6 \pm 16.4$  (SD) hemicellulose,  $31.5 \pm 15.5$  cellulose,  $15.5 \pm 9.6$  lignin,  $15.8 \pm 5.7$  crude protein, and  $7.6 \pm 7.6$  fat. In contrast, leaf parts contained a mean of  $42.3 \pm 8.3$  hemicellulose,  $28.8 \pm 7.5$  cellulose,  $14.6 \pm 6.5$  lignin,  $24.6 \pm 5.8$  crude protein, and  $2.8 \pm 0.9$  fat; insects contained a mean of  $9 \pm 2.3$  chitin,  $68.6 \pm 10.6$  crude protein and  $12 \pm 4.5$  fat. Preliminary findings indicate that females maintain a NPE:AP balance of 7.8:1 and average daily energy intake of  $407 \pm 104$  kcal, placing their nutritional strategy, as predicted, between that of frugivorous and omnivorous primates.

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### Climatic adaptation in Japanese macaques (*Macaca fuscata*) as a model for calibrating human intraspecific variation

LAURA T. BUCK<sup>1,2</sup>, ISABELLE DE GROOTE<sup>2,3</sup>, YUZURU HAMADA<sup>4</sup> and JAY T. STOCK<sup>1</sup>

<sup>1</sup>Department of Archaeology, University of Cambridge, <sup>2</sup>Department of Earth Sciences, Natural History Museum (London), <sup>3</sup>School of Natural Sciences and Psychology, Liverpool John Moores University, <sup>4</sup>Section of Evolutionary Morphology, Primate Research Institute, Kyoto University

*Homo sapiens* is a global species, a remarkable achievement for a tropical ape. Extensive phenotypic variation observed in our species may be, in part, a reflection of plasticity in response to these diverse environmental stresses. We seek to establish a base-line for intraspecific adaptation to climate by looking at outgroups e.g., non-human primates (NHPs), to better understand relative variation in humans. In this first phase we analysed latitudinal differences within Japanese macaques (*Macaca fuscata*). *M. fuscata* have the greatest latitudinal spread of any NHP, and are thus the best comparison. Climatic influences have been reported within *M. fuscata*, but a systematic study is lacking. We used linear measurements of postcrania and GMM analyses of CT-scanned crania on a sample of 80 *M. fuscata* from 4 different latitudes. There are differences in postcranial size and cranial size and shape. Yakushima Island (most southerly) is distinctive in postcranial size (smaller) but not shape. Although smaller size at lower latitudes fits Bergmann's Law, lack of consistent latitudinal pattern in the rest of the sample may suggest Yakushima's size results from resource scarcity, not climate. There are substantial cranial allometric differences between groups (led by Yakushima), yet groups can still be differentiated when this is corrected for. Allometry-free shape differences between groups show geographic patterning but do not simply reflect climatic expectations, other factors such as diet and gene-flow are likely also important. These results

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suggest climatic adaptation in the primate skeleton may be relatively modest

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### Morphological correlates of limb differentiation in the cross-sectional geometric properties of anthropoid primate metapodials

STEPHANIE H. BUI<sup>1</sup> and BIREN A. PATEL<sup>1,2</sup>

<sup>1</sup>Human and Evolutionary Biology, University of Southern California, <sup>2</sup>Cell and Neurobiology, Keck School of Medicine, University of Southern California

Experimental studies investigating primate quadrupedal mechanics have consistently demonstrated that most taxa experience higher peak vertical forces on their hindlimbs than on their forelimbs. This functional differentiation in habitual limb loading is reflected in the structural properties of the mid-diaphysis of the humerus and femur, with the latter tending to be more robust. These results support the hypothesis that long bone diaphyses respond to their external loading history. This study further tests this hypothesis by investigating robusticity differences between hand and foot bones of anthropoids with published force plate data: *Pan*, *Pongo*, *Chlorocebus*, *Erythrocebus*, *Macaca*, *Papio*, *Ateles*, *Sapajus*, *Callithrix*. Using micro-CT scans, we measured polar second moment of area in the metacarpals (Mc) and metatarsals (Mt) of digits 1 and 3. As predicted, Mt1 was more robust than Mc1 in all taxa except *Callithrix*. In monkeys the Mt3 is more robust than the Mc3, supporting the hypothesis that there is a relationship between relative bone strength and habitual loads between limb pairs. In *Pan*, however, metapodials are either equal in strength or the Mc3 is stronger than the Mt3. Chimpanzees may need relatively stronger hand bones than monkeys because their weight is supported by a relatively smaller surface area when using a knuckle-walking hand posture. This could result in greater stresses in the hand than the foot, despite absolute magnitudes of forces being higher in the latter. We conclude that the strength of hand and foot bones is a result of both their kinetics and kinematics.

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### Unstated Assumptions and Interdisciplinarity in the Study of Ancient Pathogen DNA

JANE E. BUIKSTRA

SHESC, Arizona State University

Historically, the study of ancient disease(s) has attracted scholars drawn from an eclectic mix of biomedical and social scientists, clinicians,

and historians of disease. The development of increasingly refined methods for ancient DNA study during the past quarter-century has shifted the interpretative balance into the laboratory and away from archaeological and historical contexts.

This paper will firstly consider the degree to which laboratory analyses can truly be context-free. While many researchers today focus upon defining the phylogeography of infectious diseases, refined explanatory models will require increased emphasis upon contexts and conserving the non-renewable resource base that is the archaeological record. Truly collaborative, interdisciplinary research will be required.

Secondly, focusing upon three competing models for the phylogeography of the *Mycobacterium tuberculosis* complex, this paper will illustrate the importance of close interdisciplinary collaborations in developing and implementing scientific research on ancient pathogen DNA. These three models vary considerably in estimated time depth and the manner in which human and animal hosts are invoked. It is argued here that these conflicts rest on unstated assumptions within specific fields that may lead to fatal flaws in overall research designs. These assumptions include uniformitarian principles of disease expression in paleopathology, the genetics of mycobacteria, and the specificity of mycobacterial disease expression in non-human animals and in the archaeological record. It is argued here that collaborators from genetics and bioarchaeology, for example, must share core common knowledge about their approaches and the science they represent.

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### Paleoenvironmental reconstruction at Kanapoi through use of rodent dental microwear

JENNY H.E. BURGMAN<sup>1</sup>, FREDRICK KYALO MANTHI<sup>2</sup>, J. MICHAEL PLAVCAN<sup>3</sup>, CAROL V. WARD<sup>4</sup> and PETER S. UNGAR<sup>3</sup>

<sup>1</sup>Environmental Dynamics, University of Arkansas, <sup>2</sup>Department of Earth Sciences, National Museums of Kenya, <sup>3</sup>Department of Anthropology, University of Arkansas, <sup>4</sup>Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine

Reconstructions of paleoenvironments at sites like Kanapoi offer valuable context for understanding hominin evolution during the Plio-Pleistocene. Dental microwear texture analysis offers one proxy by providing useful data on diet preferences, and hence the foods available to animals at given sites. Although most such work has been conducted on larger mammals, application of these methods to rodents may be particularly useful, as micromammals are constrained to small geographic ranges. Kanapoi

is an unusual site within Pliocene deposits of the Turkana Basin as it preserves an extensive microfaunal record, providing an opportunity to begin to explore paleoenvironment, and possibly microhabitats, using rodent microwear.

We conducted dental microwear texture analyses of fossil rodent molars ( $n=34$ ) from Kanapoi utilizing a blue-light scanning confocal microscope at 150x magnification. Scale-sensitive fractal analysis was then applied to characterize diet-related microwear textures. The fossil sample included nine taxa identified to genus, and a small group of less certain taxonomic affinity. A taxon-free comparison of the fossils to our currently available extant baseline series indicates that the rodents from Kanapoi evince relatively low texture heterogeneity compared with highly opportunistic living omnivores, such as *Mastomys coucha*. Results suggest that rodents at Kanapoi likely included grass in their diets, and were able to be somewhat selective within the patchwork of habitats at the site.

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### Pre-Axial Polydactyly in a Mid-Holocene Human Skeleton from Gobero, Niger

SCOTT E. BURNETT<sup>1</sup> and CHRISTOPHER M. STOJANOWSKI<sup>2</sup>

<sup>1</sup>Department of Anthropology, Eckerd College, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University

Polydactyly is a congenital condition characterized by a hand or foot with six or more digits. Most cases affect the first ray (pre-axial polydactyly) or fifth ray (post-axial polydactyly). While among the more common musculoskeletal defects present today, few skeletal examples have been identified from archaeological contexts. The purpose of this study is to present the oldest known human case of polydactyly, excavated at the mid-Holocene site of Gobero in Niger.

Pre-axial polydactyly was identified unilaterally in the hand skeleton of G3B41, an adult female aged 35-45 years old at death. The left first metacarpal is trifurcated with two additional heads diverging distally from the dorsal surface of the diaphysis. The normal left first metacarpal head is damaged post-mortem but the corresponding proximal phalanx and distal phalanx fragment are unremarkable. Both supernumerary metacarpal heads are roughened, with superficial pitting and the appearance of subchondral bone. One or more additional elements for articulation with these supernumerary metacarpal heads likely existed but were not recovered.

Though it is unclear how this individual would have been viewed by their community, the find is

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significant for two primary reasons: 1) Post-axial polydactyly is most common in modern individuals of African ancestry, but pre-axial polydactyly as seen here is exceedingly rare; 2) the earliest known prior archaeological case of polydactyly is Pharaoh Seti I, dating to 1290 BC. The polydactylous individual from Gobero dates to 3620 cal BC, making it the oldest case yet identified by over 2300 years.

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### The Incidence and Variance of Metopism in Three Medieval British Populations

CARLA L. BURRELL, SILVIA GONZALEZ and JOEL D. IRISH

Research Centre for Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University

The metopic suture, identified from the nasion to the bregma, typically disappears during infancy and early childhood. However, in some cases, this suture persists into adulthood and this condition is known as metopism. Metopism is a frequently recorded variant of the human cranium and the incidence, persistence and completeness of this trait varies within and between different populations. This study identifies the variation of the metopic suture in 481 crania from three Medieval samples; the St. Owen's Church Collection, Gloucestershire (n=57), the Poulton Chapel (n=344) and the Norton Priory (n=80) Collections, Cheshire.

Metopism was observed in 12.1% of all cases while incomplete variation of the metopic suture was reported in 36.4% of cases. These incomplete variations were only exhibited within the lower portion of the frontal bone identifying further observations of variation concerning the shape of the metopic suture. The most common shape recorded was the 'Wide side to side excursion' type (48%). The next frequently observed variation was the 'Linear' shape (32.6%) followed by the 'U shape' (14.9%). Finally, the 'V shape' (10.9%) and 'H Shape' (9.1%) presented a similar rate of occurrences. No significant differences were reported between the sexes, or by site. However, there is a significant difference between the prevalence rate of metopism ( $H=9.506$ ,  $p=0.009$ ) and the incomplete variation of the metopic suture ( $H=6.940$ ,  $p=0.031$ ) between all three Medieval British sites. This study presents a much higher incidence of metopism and metopic suture variation in comparison to previous research on European populations.

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### Exudate-feeding in Lorisidae: Evolutionary divergence in the toothcomb and lower molar

ANNE M. BURROWS<sup>1</sup>, ADAM HARTSTONE-ROSE<sup>2</sup> and LEANNE T. NASH<sup>3</sup>

<sup>1</sup>Physical Therapy, Duquesne University, <sup>2</sup>Cell Biology & Anatomy, University of South Carolina School

of Medicine, <sup>3</sup>School of Human Evolution & Social Change, Arizona State University

Lorisids are among the most poorly understood primates but may provide important information on primate evolution. *Nycticebus* is a gouging exudatvore while the other genera are carnivorous (*Loris* and *Arctocebus*) or frugivorous-exudatvorous (*Perodicticus*), presenting an opportunity to investigate the evolution of exudatvory in a defined group. We previously demonstrated that *Nycticebus* spp. had a robust toothcomb and molar reduction relative to *Loris*. This study was designed to probe exudatvory across the lorisids by including *Perodicticus* and *Arctocebus*. Select teeth from 121 adult lorisids were measured with sliding, digital calipers to the nearest 0.01mm. Mean dental dimensions were calculated, with the geometric mean of dimensions per specimen as a scaler, and ability of the toothcomb to resist bending forces was calculated. Mean differences were compared using a one-way ANOVA with significance set at  $p<0.05$ . The exudatvorous, gouging *Nycticebus* had a significantly higher ability in the toothcomb to resist bending forces ( $Nycticebus > Perodicticus > Arctocebus = Loris$ ). *Nycticebus* and *Perodicticus* had significantly shorter, narrower toothcombs than *Loris* and *Arctocebus*, along with reduction in  $M_3$  ( $Loris = Arctocebus > Nycticebus = Perodicticus$ ). Overall, *Arctocebus* and *Loris* consistently clustered together as did *Nycticebus* and *Perodicticus*. These results may be reflective of body size ( $Loris < Arctocebus < Nycticebus < Perodicticus$ ), but this is unlikely since all raw measurements were scaled via the geometric mean. The patterning of dental dimensions appears congruent with the differences in diet and methods of exudate harvesting across these genera.

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### Internal craniofacial morphology of high-altitude Tibetans may reflect unique adaptations to hypoxic environments

LAUREN N. BUTARIC<sup>1,2</sup> and ROSS KLOCKE<sup>2</sup>

<sup>1</sup>Department of Anatomy, Des Moines University, <sup>2</sup>College of Osteopathic Medicine, Des Moines University

High-altitude populations (>2500m) face increased respiratory pressures due to exposure to colder temperatures, lower humidity, and hypoxic conditions. Theoretically, adaptations in upper respiratory structures (i.e., nasal cavity, maxillary sinuses) could help alleviate some pressures, whereby tall/wide nasal cavities would augment oxygen uptake, tall/narrow nasal cavities would help in air conditioning processes, and/or larger sinuses could increase nitric oxide production or storage to facilitate oxygen delivery. Since previous research on high-altitude craniofacial morphology is limited, this initial study explores whether two high-altitude samples (Tibetans, Yauyos-Peruvians) exhibit different nasal-sinus morphologies compared to their

lowland counterparts (Chinese, Pachacamac-Peruvians). Utilizing 3D-rendered models from CT scans, we collected 15 linear distances measuring the external midface, internal nasal cavity, and maxillary sinuses. Nasal cavity volume, maxillary sinus volume, and a geometric mean for craniofacial size were also calculated. ANOVA and Tukey *post-hoc* tests on size-standardized measures suggest that while samples do not differ in most craniofacial measures, Tibetans present significantly taller nasal cavities compared to low-altitude Chinese ( $p=0.040$ ), and larger maxillary sinus volumes compared to both low-altitude Chinese ( $p=0.027$ ) and Pachacamac-Peruvians ( $p=0.023$ ). While regression analyses show that for most samples sinus volume is predominantly explained by facial height and breadth dimensions, relatively larger maxillary sinuses among Tibetans appear primarily related to anteroposterior length relationships. Thus, Tibetans display a unique internal craniofacial morphology, characterized by enlarged and elongated maxillary sinuses. We suggest these relatively large sinuses could relate to the increased levels of nitric oxide previously found among high-altitude Tibetans, allowing further adaptation to hypoxic environments.

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### Building America on Broken Bones: Comparative Analysis of Antemortem Fracture Patterns of Three Contemporary American Poorhouse Cemeteries

JENNIFER F. BYRNES

Social Sciences, University of Hawaii - West Oahu

The Industrial Revolution in the United States created major manufacturing centers built on the backs of the swelling immigrant population. Recently, several poorhouse cemeteries that were used to bury the urban poor have been excavated and analyzed. In the current study, three contemporaneous poorhouse cemeteries are compared via antemortem fracture rates and patterns: the Albany County Almshouse Cemetery (1826-1926), the Erie County Poorhouse Cemetery (1851-1913), and the Milwaukee County Institutional Grounds Cemetery (1882-1925). The primary question is whether the dominant industries in each urban center resulted in different fracture patterns in the skeletal samples from each city. Secondly, are there observable inter-sample fracture differences between the sexes? The cemetery samples have similar overall demographics and similar inter-sample antemortem fracture patterns when examining males versus females. One obvious difference in prevalence is seen in the nasal region, with Milwaukee having the lowest nasal fracture rate (7.04%), Albany second highest (19.1%), and Erie County having the highest prevalence (25.5%). Only males had nasal fractures for Milwaukee, while Albany and Erie had both males (19.4% and 21.7%, respectively) and females (18.2% and

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7.1%, respectively). Fractures of the upper limbs were similar in prevalence, with variations probably related to preservation of epiphyseal ends. The lower limb patterns were slightly different, with higher rates of tibial, fibular, and patellar fractures in the Erie County cemetery. There are similarities in injuries in urban poor during this time, and some interesting differences that may not be related to occupation but possibly interpersonal violence.

### Genetic Ancestry, Race, and National Belonging in Argentina: Interdisciplinary Investigations

GRACIELA S. CABANA<sup>1</sup>, MARCELA MENDOZA<sup>2,3</sup> and LINDSAY SMITH<sup>4</sup>

<sup>1</sup>Anthropology, University of Tennessee, Knoxville,

<sup>2</sup>Anthropology, University of Oregon, Eugene,

<sup>3</sup>Institute of Decision and Cognitive Studies, University of Oregon, Eugene, <sup>4</sup>Anthropology, University of New Mexico

Social science and bioethics scholars have raised the question of whether genetic ancestry-based studies encourage a new form of race essentialism. To develop a better understanding of the dynamic between genetics and race, these scholars have called for further empirical research in varied social-cultural settings, as well as extending analyses into related notions of national belonging.

In response to this call, we formed an interdisciplinary team comprised of three anthropologists (one biological, two cultural) and one statistician. Our team is engaged in an ongoing investigation of how genetic ancestry inference affects notions of race and national belonging in Argentina. The study combines genetic ancestry analyses with the exploration of individual and group attitudes via a longitudinal ethnographic study, participant observation, and evaluation of primary and secondary sources.

More broadly, the cross-cultural and interdisciplinary collaboration allows for a recursive exploration of the meaning of race and intersectionality. Through team discussions about language use, form and questionnaire creation, and sampling, we have been forced to examine our tacit assumptions about categories and their utility as research concepts. The nature of this collaboration, with all team members participating in each aspect of data collection and analysis (rather than a traditional retreat to disciplinary strengths where, for example, the biological anthropologist does lab work and the cultural anthropologist, the ethnography) we have not only learned from each other but also about the epistemology of "population-making" in our respective fields.

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### Commingled, Disarticulated, and Eroded... Oh My! Navigating Bioarchaeology in the Arabian Peninsula

ALYSON C. CAINE

Interdisciplinary Humanities, University of California, Merced

Bioarchaeology in the Arabian Peninsula is characterized by brittle, eroded, and fragmented human remains. Secondary burial practices, looting, and poor climate have devastated the bioarchaeological record of individuals from prehistoric Arabia, leaving limited information to be gained about the individual. The aim of this poster is to highlight the importance, although arduous, bioarchaeology in the Arabian Peninsula is to understanding prehistoric society and identity. The results of two bioarchaeological projects will be utilized as the materials to present the possible demographic outcomes of analysis.

Two different projects in the Arabian Peninsula, Batinah, Oman, and Ra's al-Khaimah, UAE, depict the variable information obtainable of identity. One site is comprised of a minimum of 504 commingled, disarticulated individuals from a Wadi Suq (2000-1200 BC) cemetery comprised of four tombs. The other site is comprised of 64 tombs with a minimum of 27 discrete internments dating to Hafit (3200-2700/2500 BC)/Iron Age (1000-300 BC). Within and between these sites variation is observed in level of preservation and completeness, the majority of skeletal elements were recorded with fragmentation and erosion of cortical surface. Although cortical surface erosion and fragmentation is common in skeletal elements from these sites, distributions of age, sex, stature, pathological conditions were recorded providing an idea of demographic distribution and pathological condition prevalence. While sample size and preservation restricted statistically significant instances, these sites provide comparative samples and jumping off point for future excavations and research in the region, which will contribute to the greater knowledge about identity for the region.

### The effects of osteoarthritis on age at death estimates from the human pelvis

STEPHANIE E. CALCE<sup>1</sup>, HELEN K. KURKI<sup>1</sup>, DARLENE WESTON<sup>2</sup> and LISA GOULD<sup>1</sup>

<sup>1</sup>Anthropology, University of Victoria, <sup>2</sup>Anthropology, University of British Columbia

Predictable age-progressive morphological arthritic traits have been used to derive several methods of estimating adult age at death in various skeletal joints. This study examined the degree of error in age at death estimates when osteoarthritis (OA) is present in age estimation methods based on three separate pelvic joint areas: 1) pubic symphysis, 2) auricular surface, and 3) acetabulum on a modern known-age European cemetery sample (N=252).

Age at death ranged from 17-99 years (*mean*=50.9 years). OA in the pelvic joints was evaluated using standard ranked categorical scoring. Composite OA scores were derived through principal component analysis. Blind age assessments and all analyses were performed separately by region. Error between adult age groups (young, middle, old) and between OA severity groups (low, middle, high) was evaluated using one-way ANOVAs with post-hoc testing, ordinary least squares regression, and transition analysis with a cumulative probit model. Ages-at-transition were compared with Nphases2.

Three significant results emerge. First, OA severity has an effect on the accuracy of age estimates from os coxa joints in this sample. Second, this influence is most significant for different age cohorts in each joint region, demonstrating that varied rates of arthritic trait progression occur between the auricular surface, pubic symphyses, and acetabulum. Third, those with OA appear to be aging faster, a consistent trend among the os coxa regions. These results have significant consequences for understanding the rate of bone remodeling in relation to disease, aging, and the evaluation of skeletal age indicators.

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### Differences between Human and Chimpanzee Costo-vertebral Joint Anatomy

WILLIAM É. CALLISON and DANIEL E. LIEBERMAN  
Department of Human Evolutionary Biology, Harvard University

Humans differ from other non-human primates, including chimpanzees, in being adapted for long-term endurance activities such as running, but how might the anatomy of the thorax facilitate increased aerobic capabilities? During sustained high aerobic activities, humans need to breathe approximately 60.4 milliliters of air/minute per kilogram of body mass, but it is unknown if differences in rib and vertebral anatomy enable the human thorax to produce such large volumetric changes and high flow rates. To investigate this challenge, a series of morphological measurements were taken on 7 adult *Homo sapiens* and 6 adult *Pan troglodytes* skeletons. Photographic images of the articular facets on the heads of the ribs and the corresponding superior and inferior costal facets on the vertebrae were used to make 3D computer models and determine the included angle of each costo-vertebral joint. We found that humans exhibit a distinctly different costo-vertebral joint morphology than chimps, with the superior (n=54, average included angle=72.90°) and inferior (n=68, average included angle=67.37°) costal facets of the vertebrae being significantly ( $p<.0001$ ) more convex than the flattened facets

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found in chimps (n=48, average included angle=-6.32°; n=60, average included angle=-4.49°, respectively). Furthermore, the corresponding inferior articular (n=53, average included angle=50.95°) and superior articular (n=53, average included angle=-42.59°) rib facets were significantly (p<.0001) more concave in humans than in chimps (n=48, average included angle=-1.44°; n=48, average included angle=-2.87°, respectively). These differences support the hypothesis that human costo-vertebral joint anatomy evolved to facilitate increased thoracic movement and simultaneously increase ventilatory capacity during endurance activities.

### Limb biomechanics and terrestrial mobility among Pleistocene and Holocene foragers and herders in northern, eastern, and southern Africa

MICHELLE E. CAMERON and JAY T. STOCK

Phenotypic Adaptability, Variation and Evolution (PAVE) Research Group, Department of Archaeology and Anthropology, University of Cambridge

Mobile foraging strategies were undertaken throughout Africa during the Pleistocene and Holocene, and persisted to varying extents after the adoption of pastoralism. The morphological implications of mobile lifeways may be examined through biomechanical analyses of lower limb cross-sectional geometric properties (CSGPs). This paper will test whether large-scale spatial and temporal similarities in lower limb CSGPs exist between prehistoric foraging and herding groups from northern, eastern, and southern Africa. Femoral and tibial CSGPs were examined among three prehistoric foraging groups (Iberomaurusian; Later Stone Age, or LSA, Tanzanian; and LSA Cape coast foragers) and four herding groups (Badari herders; Masai herders; LSA southern African central interior herder-foragers; and Namib Desert herder-foragers) from northern, eastern, and southern Africa respectively. Midshaft (50%) torsional strength ( $J$ ), total subperiosteal area ( $TA$ ), and diaphyseal shape indicators ( $I_{max}/I_{min}$  and  $I_x/I_y$ ) were compared. CSGPs were calculated from periosteal contours obtained using periosteal molds and 3D laser surface scans.

Namib Desert and central interior herder-foragers, LSA foragers from Tanzania, and southern African LSA Cape coast foragers had significantly higher  $TA$  and  $J$  than Badari herders, Masai herders, and Iberomaurusian foragers. Significant differences in  $I_x/I_y$  and  $I_{max}/I_{min}$  were driven by high values among LSA Cape coast foragers. Low Iberomaurusian  $TA$  and  $J$  relative to other foragers indicate that foraging lifeways may encompass a range of mobility patterns and lower limb morphologies. Additionally, similarities between central interior and Namib Desert herder-foragers and exclusively foraging LSA groups indicate that biomechanical indicators of

terrestrial mobility are not always distinguishable between mobile foragers and herders.

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### The influence of body size in age estimation from the pelvic joints: methodological considerations

VANESSA CAMPANACHO

CIAS - Research Centre for Anthropology and Health, University of Coimbra, Portugal

It has been suggested that variable rates of skeletal ageing among adults may be caused by genetic, cultural and environmental factors. However, few studies have investigated the possible effects of confounding factors in skeletal metamorphosis with age, such as occupation, diseases, drug and alcohol consumption, pregnancy and birth and body size. The majority of studies have analysed the effects of those factors on age estimation methods' accuracy and bias. It is important to understand how a particular factor may influence an age estimation method, but it may not provide a complete picture of the direct effect it may have on skeletal degeneration with age. Therefore, the present study investigated if stature and body mass affected age-related criteria of the acetabulum in adult individuals of both sexes from the Coimbra (n= 311) and the William Bass Donated Skeletal collections (n= 236). Three sets of age-related criteria were analysed: 1) six acetabular traits, 2) two components (weighted linear combinations of traits), obtained with PCA, indicating a higher degenerative variance between the two fossa traits and between the four lunate surface traits, and 3) a composite score, which was the sum of all trait scores. Logistic regression analysis indicated that body mass and stature only influenced some of the age-related criteria, with different criteria being affected between both collections. The present investigation enhances our knowledge and understanding of the skeletal ageing process in adults by following a direct analysis of the body size effect in acetabular age-related criteria.

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### The 'Drunken Monkey' Hypothesis and spider monkeys (*Ateles geoffroyi*): Further Evaluation

CHRISTINA J. CAMPBELL<sup>1</sup>, VICTORIA R. WEAVER<sup>1</sup> and ROBERT DUDLEY<sup>2</sup>

<sup>1</sup>Anthropology, California State University, Northridge,

<sup>2</sup>Integrative Biology, University of California, Berkeley

The Drunken Monkey Hypothesis (DMH) proposes that human consumption of alcohol stems from a deep-rooted affinity present in all frugivorous nonhuman primates for naturally occurring ethanol within ripe fruit. Ethanol is naturally produced by the metabolic activity of fermentative yeasts within fruit pulp as the fruit ripens. There has been an increase in the number of studies examining the main tenets of the DMH over a variety of animal species (both primate and non-primate) showing that wild animals may in fact regularly consume naturally occurring ethanol. Previously we have presented data on ethanol concentrations in *Spondias mombin* (Anacardiaceae) fruits consumed by free ranging spider monkeys (*Ateles geoffroyi*) on Barro Colorado Island, Panama (BCI). Specifically, we have shown that more than 85% of the fruits collected that were partially consumed by the monkeys contained measureable levels of ethanol (typically in the 1-2% range). In this presentation we readdress these data from the broader perspective of foraging cues and ripeness and discuss ways in which ethanol may be used as an indicator of the palatability of a fruit. We also present new data on the presence of Ethyl Glucuronide (EtG), a metabolite of ethanol, in the urine of spider monkeys.

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### Retrospective correspondence analysis of a commingling event

JESSICA L. CAMPBELL

Anthropology, University at Albany - State University of New York

The Zona de Entierros (Mayapan, Yucatan) is a commingled assemblage consisting of taphonomically altered human and faunal bone. It consists of 7319 fragments representing at least 20 individuals with evidence of burning and processing. The purpose of this study is to identify relationships within this assemblage using original data and excavation records with the following goals: 1) identify possible relationships that may lead to re-association of remains, 2) lead to a more informed interpretation of this event, and 3) demonstrate the utility of correspondence analysis (CA) for commingling recoveries.

CA identifies meaningful relationships and analyzes the frequencies of bone observed by transforming the original data into coordinates, which are then plotted to visually access relationships between units, bones, and treatment. Results indicated a pattern of concentrated burning, but the highest densities of fragments were not synonymous with burning. The cranial fragments were the most burned, processed, and fragmented of the anatomical regions; the

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lower limb and hands were spatially associated but the least altered. Elements of the feet had the strongest association with the trunk, and both of these regions had the greatest processing.

The overall conclusion of this study indicates that there is no anatomical order to indicate bodies were complete at the time of deposition, and suggests dismemberment and fragmentation occurred prior to deposition and burning. As a methodology, CA is a useful tool for commingling recoveries to assist in the clarification of complex relationships and the re-creation and increased comprehension of a commingling event.

### Warm pools, upwellings, and an early glacial. Are "mid-Pliocene" climate transitions reflected in the eastern African records?"

CHRISTOPHER J. CAMPISANO<sup>1,2</sup> and KAYE E. REED<sup>1,2</sup>

<sup>1</sup>Institute of Human Origins, Arizona State University,

<sup>2</sup>School of Human Evolution & Social Change, Arizona State University

The Piacenzian Age (~3.60-2.58 Ma) of the Pliocene, particularly the mid-Piacenzian, was a time of significant paleoclimate variability leading up to the onset and intensification of Northern Hemisphere glaciation. For example, a "failed glacial" (Marine Isotope Stage M2) occurred just prior to the well documented mid-Pliocene Warm Period (mPWP), a major focus of paleoclimatic research. This time interval has also been suggested to include significant paleogeographic changes that would have influenced ocean circulation and global climate, such as the final closure of the Central American Seaway and constriction of the Indonesian Throughflow. Most climate models indicate that northeast African climate was, in general, both colder and wetter during the mPWP. Using various paleorecords from Hadar, Ethiopia, we test for any correspondence between these global scale changes and local paleoenvironmental impacts. Changes in the Hadar faunal and floral assemblages may show a response to the cooling of MIS M2, but the directionality of this change compared to the expected response is dependent on the climate model used. In contrast, a shift in the Hadar/Afar record beginning ~3.2-3.1 Ma towards more open habitats is coincident not only with a significant increase in dust recorded in marine cores from the Gulf of Aden, but also broadly correlates with the proposed development of modern oceanic upwelling cells. In particular, as suggested by previous research, a cooling of the western Indian Ocean related to the constriction of the Indonesian Throughflow may have impacted the Somali Current and led a decrease in rainfall over northeastern Africa.

### Abrupt decline in mantled howlers (*Alouatta palliata*) but not in sympatric white-faced capuchins (*Cebus capucinus imitator*) in a tropical dry forest conservation area in Costa Rica

FERNANDO A. CAMPOS<sup>1,2</sup>, KATHARINE M. JACK<sup>1</sup> and LINDA M. FEDIGAN<sup>2</sup>

<sup>1</sup>Department of Anthropology, Tulane University,

<sup>2</sup>Department of Anthropology and Archaeology, University of Calgary

Long-term monitoring is essential for uncovering forces that shape population size and demographic structure, assessing environmental impacts, and evaluating conservation outlooks. Here, we report on disparate long-term population trends in sympatric primate species, mantled howlers (*Alouatta palliata*) and white-faced capuchins (*Cebus capucinus imitator*), that inhabit tropical dry forest in Sector Santa Rosa, Costa Rica, based on 15 park-wide censuses collected over a 43-year period. We have previously described population growth in both species that reached approximate steady states along different timelines. Recently, we observed an abrupt decline of approximately 40% in the howler population that occurred between censuses in 2007 and 2011 and continued through 2015, during which period the capuchin population held approximately steady. Although the causes of the howler population decline remain unclear, several noteworthy climate trends occurred during this time that indicate increasing climate variability and greater potential for thermal stress: (1) prolonged oscillations in the dominant climate regime from La Niña to El Niño dominated phases, (2) a severe drought, and (3) a clear signal of climate warming. In addition, we examine a timeline of relevant regional events to evaluate evidence for several hypotheses, including epidemic disease, chemical exposure, and food resource failure, which have been proposed in conjunction with a spate of recent howler die-offs elsewhere. Although speculative, our findings suggest cause for concern and highlight the need for physiological and epidemiological investigations into the causes of this abrupt decline.

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### Nutritional Balancing of Milk: Examining Nutritional Variability in Human Milk through a Geometric Framework

EMMA C. CANCELLIERE<sup>1,2</sup>, KATIE HINDE<sup>3,4</sup>, DAVID RAUBENHEIMER<sup>5</sup> and JESSICA M. ROTHMAN<sup>1,2,6</sup>

<sup>1</sup>Anthropology, The Graduate Center, City University of New York, <sup>2</sup>, New York Consortium for Evolutionary Primatology, <sup>3</sup>School of Human Evolution & Social Change, Arizona State University, <sup>4</sup>Center for Evolution and Medicine, Arizona State University,

<sup>5</sup>Faculty of Veterinary Science, The University of Sydney, <sup>6</sup>Anthropology, Hunter College

The macronutrient composition in milk is thought to be a result of environment, diet, and life history characteristics. In turn, the composition of milk has implications for duration of nutritional reliance on the mother, infant growth and development rates, and weaning age. Within the order primates, milk is typically low in protein compared to other mammals, which supports the slow, linear growth characteristic of primates. Numerous studies have shown that human milk is not uniform nutritionally; the macronutrients in milk vary in relation to maternal, environmental, genetic, and temporal factors. This variation is present both within and between women, contributing to differences in the nutritional intake of infants. To better understand these dynamics, we considered the fat, protein and carbohydrate concentrations reported in the literature using the geometric framework of nutrition. We found that the relative proportion of protein in human milk is constant across lactational stage, while relative proportion of lipids shifts upward over the course of lactation. Further, we find that the relative proportion of fat and carbohydrates are inversely proportional. This relationship may assist in regulating the proportion of protein present in milk at any given time. This is supported by our finding of nutrient ratio shifts across lactation, consistent with changing breastfeeding physiology, infant developmental priorities, and weaning transitions. Lastly, our findings in humans are consistent with similar findings across primates, signaling the importance of these mechanisms in life history patterning across the order.

### Long bone cross-sectional diaphyseal shape follows different ontogenetic trajectories in captive and wild gorillas

STEPHANIE L. CANINGTON<sup>1</sup>, ADAM D. SYLVESTER<sup>1</sup>, M. LORING BURGESS<sup>1</sup>, JUHO-ANTTI JUNNO<sup>2</sup> and CHRISTOPHER B. RUFF<sup>1</sup>

<sup>1</sup>Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>2</sup>Department of Archaeology, University of Oulu

Experimental and observational studies on a diversity of mammalian taxa have demonstrated the extent to which long bone diaphyseal structure is developmentally plastic, responding to mechanical forces during the individual's life. The effects of captivity on limb bone structure are unclear, with some studies indicating little if any effect, and with vague definitions of "captivity". The tendency to lump all zoo specimens within the same "captive" status may misrepresent the range of enclosure compositions and complexities, nutritional qualities of diet, and developmental or behavioral effects of long-term vs. short-term captivity.

Our study analyzed 12 Western lowland gorillas (*G. g. gorilla*) from zoos, all well-documented as

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having been captive since infancy, defined as up to 2 years of age. These included 8 adults (fully fused epiphyses) and 4 juveniles (dental age 0.8-4 years). Captive specimens were compared with 36 adult and 28 age-matched juvenile wild-collected specimens. Peripheral quantitative computed tomography was used to measure cross-sectional properties in mid-diaphyseal regions of femora, tibiae, and humeri. Cross-sectional shapes were assessed as AP/ML bending strength ratios ( $Zx/Zy$ ), as well as percent cortical area (%CA).

Differences between captive and wild juvenile specimens were not statistically significant for both measures of cross-sectional shape ( $p>0.25$ ). Adults, however, differed significantly in measures of  $Zx/Zy$  in all three bones ( $p<0.02$ ), as well as %CA in humeri ( $p<0.01$ ). Our results demonstrate that ontogenetic trajectories of long bone cross-sectional shape vary between captive and wild gorillas, which begin with very similar morphologies, but diverge throughout life.

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### Combining functional and forward genomics to explore the evolutionary developmental regulation of primate long bone length variation

TERENCE D. CAPELLINI<sup>1,2</sup>, MICHAEL HILLER<sup>3</sup>, JESSICA WILLEN<sup>1</sup>, ANTHONY W. WOHNS<sup>1</sup> and HEATHER DINGWALL<sup>1</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University, <sup>2</sup>Genomics, Broad Institute of MIT and Harvard, <sup>3</sup>Molecular Cell Biology and Genetics, Max Planck Institute of Molecular Cell Biology and Genetics

Differences in the lengths, shapes, and proportions of the fore- and hindlimb long bones reflect the skeletal adaptations primates have evolved to occupy diverse ecological niches. From an evolutionary perspective, this diversity reflects the actions of natural selection on variation in regulatory sequence governing pre- and postnatal developmental processes. To date, very few sequences have been identified that mediate length variation and it remains unclear whether primates with similar limb phenotypes have utilized similar or different regulatory mechanisms. Here, we address these issues by generating and synthesizing functional genomic, comparative genomic, and morphological datasets in the context of limb development and primate evolution. We have used the assay for transposase-accessible chromatin (ATAC-seq) to reveal genome-wide open chromatin "regulatory" profiles for the embryonic long bones. We reveal "regulatory" regions that are shared as well as unique to each skeletal element. Next, we employ comparative genomics and forward genomics approaches on these regulatory sequences to reveal sequences that have

evolved in parallel in primates exhibiting similar limb phenotypes. For example, we find a number of potentially informative sequences shared between humans and tarsiers that may underlie hindlimb elongation in both primates. One locus consists of a regulatory enhancer intronic to the gene *Biglycan*, a proteoglycan expressed in cartilage growth plates whose loss results in bone length alterations. Surprisingly, modifications to this sequence are apparent in other mammals that also exhibit hindlimb elongation suggestive of a broader evolutionary trend in parallelism. These sequences are currently being tested in the mouse.

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### Functional Morphology of the Hominoid Ankle Joint: Locomotor Activity and Shape Variation of the Tibial Plafond

MELANIE A. FRELAT<sup>1</sup>, TEA JASHASHVILI<sup>2,4</sup> and KRISTIAN J. CARLSON<sup>3,4</sup>

<sup>1</sup>UMR 7268 ADES, Aix-Marseille University/EFS/CNRS, <sup>2</sup>Department of Geology and Palaeontology, Georgian National Museum, <sup>3</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California, <sup>4</sup>Evolutionary Studies Institute, University of the Witwatersrand

Recent studies of ankle joint geometry, specifically outline shape of the tibial articulation with the talar trochlea (i.e., tibial plafond), highlight conflicting signals in functional correspondence between articular surface outline and (vertical) climbing frequency. This uncertainty hampers inferring activity patterns in fossil hominoids, including hominins, based on distal tibia morphology, and the ankle joint specifically. To further clarify functional signatures of diverse locomotor repertoires within the tibial plafond, we used 3D geometric morphometrics to document morphological variation within a sample of extant hominoids (*Gorilla beringei*, *G. gorilla*, *Homo sapiens*, *Pan troglodytes*, *Pongo abelii*, *P. pygmaeus*) and a non-hominoid anthropoid (*Papio sp.*). We also evaluated correlations between tibial plafond 3D shape and epiphyseal orientations (i.e., tibial plafond and tibial plateau angles relative to the shaft).

Two between-group PCAs were performed, using either locomotor or phylogenetic groupings. Better cluster separation was observed within the former, supporting the presence of a functional signal in the region, but not in a way that supported the hypothesis of a trapezoidal-shaped (anteriorly-widened) tibial plafond being associated with (vertical) climbing frequency. The absence of a partial or fully anteroposterior-keeled tibial plafond, or the lack of a marked functional mortise, differentiated bipeds from non-bipeds, including climbers. A strong correlation between corresponding PC scores and tibial plafond angle relative to the shaft corroborates both features as

useful skeletal correlates differentiating habitual bipedalism. Collectively, results suggest the combination, or perhaps either feature used in isolation, may be a useful mechanism for inferring ankle functional morphology in hominids or extinct hominins.

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### An application of structure from motion to document the decomposition of hacking wounds

CONNOR D. CARLTON<sup>1</sup> and SAMANTHA MITCHELL<sup>2</sup>

<sup>1</sup>Biological Sciences, Sam Houston State University, <sup>2</sup>Sociology, Social Work and Anthropology, Texas Tech University

Over the past decade, Structure from Motion (SfM) has increasingly been used as a means of digital preservation and for documenting archaeological excavations, architecture, and cultural material. However, few studies have tapped the potential of using SfM to document and analyze taphonomic processes affecting burials for forensic sciences purposes. This paper utilizes SfM models to elucidate specific post-depositional events that affected a series of three human cadavers deposited at the Southeast Texas Applied Forensic Science (STAFS) Facility. Prior to deposition, a series of cuts were inflicted on each cadaver using a non-serrated machete. Afterwards, remains were deposited and placed within enclosures. For a series of three months a single lens reflex (SLR) camera was used to capture a series of overlapping images at periodic stages in the decomposition process of each cadaver. These images are processed through photogrammetric software that creates a 3D model that can be measured, manipulated, and viewed. This project used photogrammetric and geospatial software to map entomological changes in decomposition and movement of the body from original deposition points. Project results indicate significant movement of metacarpals and metatarsals immediately after deposition and increased entomological activity in areas afflicted by sharp force trauma. Furthermore, this project argues the use of SfM has potential to contribute to decomposition studies for time of death analyses. The results of this study indicate photogrammetry is an efficient, relatively simple, and affordable tool for the documentation of decomposing hacking trauma.

## ABSTRACTS

### Food and its Form: Cooking Shapes the Gut Microbiome

RACHEL N. CARMODY<sup>1</sup> and PETER J. TURNBAUGH<sup>2</sup>

<sup>1</sup>Department of Human Evolutionary Biology, Harvard University, <sup>2</sup>Department of Microbiology & Immunology, University of California, San Francisco

The trillions of microbes resident in the human gut contribute importantly to multiple physiological processes, including digestion, detoxification, and energy regulation. These profound yet variable influences on the human phenotype offer targets for natural selection and contexts for human-microbial co-adaptation. Therefore, studies of factors dictating the structure and function of the gut microbiome, such as diet, permit a more comprehensive view of the selective forces driving human evolution. To date, investigations of dietary impacts on the gut microbiome have compared diets differing in composition, e.g. plant-based vs. animal-based, high-fat vs. low-fat, additives vs. no additives. However the human-specific, common, and ancient practice of cooking a given food could also be expected to impact the gut microbiome through heat-induced effects on the bioavailability of nutrients and xenobiotic compounds. Using conventional and gnotobiotic mouse models, we show that a tuber diet served cooked versus raw alters the membership, abundance, transcription, and physiology of the gut microbial community, with effects driven by heat-associated improvements in starch digestibility and inactivation of native foodborne antimicrobial compounds. These changes are relevant to host energy gain, with gut microbial communities conditioned on raw diets enhancing energy harvest when transplanted into germ-free recipients. Our results suggest that diet-driven interactions between host and microbiome depend on both the food and its form, and prompt the hypothesis that the human holobiont may reflect a legacy of cooking-related selection pressures.

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### Paleobiogeography of the Colobinae

STEVIE CARNATION

Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University

To date, most colobine biogeographic hypotheses have been based on molecular data and focused on the origin and dispersal of modern forms, leaving a gap in our knowledge of the evolutionary history of this group. Thanks to recent advances in the phylogenetic study of fossil colobines, it is possible to investigate the true biogeography of this clade throughout time. This study mapped the geographic regions of all

fossil and extant colobine taxa on a genus-level total evidence phylogeny and inferred the timing of dispersal events based on temporal data for fossil specimens.

Results indicate an East African origin for the colobine clade, with at least two dispersals into Eurasia, and migration throughout Africa. In the late Miocene, a *Mesopithecus*-like form invaded Eurasia and quickly diversified. Pliocene colobine *Dolichopithecus* appears in Eurasia alongside *Mesopithecus*, but it's unclear whether this lineage dispersed directly from Africa or evolved from *Mesopithecus* ancestors. Certain large-bodied colobines (such as *Rhinocolobus*) from East Africa migrated north in the early Pliocene and gave rise to some modern Asian forms, while members of the genus *Paracolobus* moved west through central Africa and diversified into the modern African taxa. At least one colobine lineage dispersed to South Africa ~3.3-1.5 Ma, likely coinciding with the migration of papionins, hominins, and other mammals taking place in this corridor during the Plio-Pleistocene. Hopefully, the recent discoveries of fossil colobines in the Miocene and Pliocene of Asia will illuminate more specific migratory and dispersal patterns of the Colobinae following their arrival to the continent.

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### Hominids adapted to metabolize ethanol long before human-directed fermentation

MATTHEW A. CARRIGAN

Department of Biology, Haverford College, Natural Sciences Department, Santa Fe College

Many modern human diseases are attributed to an incompatibility between our current environment and the environment for which our genome is adapted. For example, the emergence of obesity, diabetes, and hypertension has been associated with a recent increase in the availability of refined sugar. The fossil record provides no indication of when human ancestors first consumed ethanol-rich food, so it is unclear if adaptationist explanations underlie human alcoholism. We used a paleogenetic approach to examine alcohol dehydrogenase class IV (ADH4), the first alcohol metabolizing enzyme in the digestive tract. We resurrected ancestral ADH4 enzymes from various points in the ~70 million years of primate evolution, and identified a single mutation that endowed our ancestors with a markedly enhanced ability to metabolize ethanol. The fixation of this variant occurred within the ancestral population of humans and gorillas ~10 Mya – a few million years after the mid-Miocene Climatic Transition that initiated the shrinking of forests in Africa, and approximately when our ancestors began transitioning to an increasingly terrestrial lifestyle. This episode of enzyme evolution may indicate the first time

our ancestors were exposed to (and adapted to) substantial amounts of dietary ethanol. Because fruit collected from the forest floor is expected to contain higher concentrations of ethanol than similar fruits hanging on trees, these results support the hypothesis that genetic adaptations enhancing ethanol metabolism could have enabled our ape-ancestors to exploit inferior, fall-back foods when preferred foods were scarce, and hence contributed to our ancestors' transition to a terrestrial lifestyle.

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### Allocare in a captive population of hamadryas baboon (*Papio hamadryas*)

AMANDA RAE CARTER

Anthropology, UNC - Charlotte

The goal of this project was to examine the social dynamics among extended matrilineal hamadryas baboons (*Papio hamadryas*) housed at the North Carolina (NC) Zoo in Asheboro, North Carolina. Specifically, I investigated the putative existence of allocare, defined as care provided to an infant by a conspecific other than the mother. Allocare does not typically occur in wild populations in which females disperse from their natal groups. Previous research at the NC Zoo suggested the presence of allocare behaviors in this population. I hypothesized that allocare is strongly dependent upon the existence of extended female kin-groups in captivity. To test this hypothesis, I collected data on the social interactions of four baboons (ages 1-3 years) using 15-minute focal animal sampling during zoo operational hours over the course of 14 weeks, yielding approximately 200 hours of observations. I predicted that infants/juveniles who were members of an extended kin network (EKN) would be the focus of more allocare-taking than infants/juveniles who lacked an EKN. Multi- and univariate statistical analyses were used to identify which variable(s) best predict variation in mean rates of allocare behaviors. My findings supported my hypothesis that allocare was dependent upon the existence of EKNs. Tinka, the juvenile with the longest matriline, was observed receiving allocare more frequently than the other three focal subjects, ( $p = 0.04$ ). An effect of matriline was also observed on the frequency at which the focal subjects would approach conspecifics ( $p < 0.0001$ ) as well as average hourly rates of agonism ( $p < 0.0001$ ).

### Two-Way Anthropogenic Hybridization between Invasive *Callithrix jacchus* and *C. penicillata* with Endemic *C. aurita*: A Threat to Marmoset Conservation

RODRIGO S. CARVALHO<sup>1,2</sup>, JOANNA

MALUKIEWICZ<sup>3</sup>, ANDREA M. OLIVEIRA<sup>3</sup>, DANIEL G.

## ABSTRACTS

PEREIRA<sup>1</sup>, SILVIA LOIOLA<sup>2</sup>, ELIZEU F. CARVALHO<sup>1,2</sup>, DAYSE A. SILVA<sup>1,2</sup> and HELENA G. BERGALLO<sup>1</sup>

<sup>1</sup>Ecology and Evolution, State University of Rio de Janeiro, <sup>2</sup>DNA Diagnostics Laboratory, State University of Rio de Janeiro, <sup>3</sup>Animal Biology, Federal University of Viçosa

The endangered *Callithrix aurita* marmosets, endemic to the SW Brazilian Atlantic Forest, face threats from deforestation and competition with invasive *C. jacchus* and *C. penicillata*. The latter species have been introduced to SW Brazil through illegal pet trading and now occur in artificial sympatry with *C. aurita*. Consequently, invasive congeners interbreed with *C. aurita* and such hybridization may threaten the genetic integrity of the native species. A conservation plan is now active to preserve remaining *C. aurita* populations, along with their standing genetic variation. Thus, genetic introgression from invasive marmosets into *C. aurita* populations carries important conservation implications. To better understand marmoset hybridization in SW Brazil, we are examining two-way hybridization between *C. aurita* and *C. jacchus/C. penicillata* by using the mitochondrial COI and Y-chromosome SRY loci to genetically confirm such interbreeding. We sampled a total of 112 marmosets, which included *C. aurita* from São Paulo (SP) and Rio de Janeiro (RJ) states, RJ hybrids, and *C. jacchus* and *C. penicillata* native to northern and central Brazil, respectively. The presence of *C. aurita* x *C. jacchus/C. penicillata* hybrids was genetically confirmed in both RJ and SP, along with individuals of the three parental species. Further, the genetic data from RJ showed the occurrence of marmoset social groups composed of parental species and hybrids and other groups containing only hybrids. These results are part of a quickly escalating situation that seriously threatens the genetic integrity of *C. aurita*.

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### The Distribution of CFTR Haplotypes in Brazilian Quilombos as a Consequence of History

CAROLINA CARVALHO GONTIJO<sup>1</sup>, DIANA MORAES<sup>1</sup>, CAMILA X. DE CARVALHO<sup>1</sup>, ELSA MGS. COELHO<sup>1</sup>, CELSO T. MENDES-JUNIOR<sup>2</sup>, GILVÂNIA FEIJÓ<sup>1</sup>, MARIA DE NAZARÉ KLAUTAU-GUIMARÃES<sup>1</sup> and SILVIENE F. DE OLIVEIRA<sup>1</sup>

<sup>1</sup>Departamento de Genética e Morfologia, Universidade de Brasília, <sup>2</sup>Departamento de Química, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, USP

Populations with different histories show different strength and extension of LD. That information highly informative about migration processes and admixture. rs916727 and rs10487362 are extragenic markers in strong LD with the CFTR gene. rs113993960 is the most common causal mutation in CFTR, accounting to as much as 70%

of the pathogenic alleles found worldwide, and especially in populations of European descent. Quilombos are Brazilian peasant populations (campesinos) defined by a strong, though not exclusive African ancestry, and by a shared history of resistance against formal slavery and its consequences.

Here, we present the analyses of rs916727, rs10487362, and rs113993960 haplotypes in four Quilombos from Central and Northeastern Brazil. The mutations were assessed by PCR-RFLP, as previously described. Our statistical analyses described basic populations genetics parameters and evaluated LD.

We did not observe pathogenic alleles. The haplotypes we found did not differ from those observed in urban Brazilian populations. The most frequent haplotypes were those most common in African and European populations (1000 Genomes and HapMap). That observation agrees with our previous findings on populations genetics. As one would expect from the known general history of Quilombos, these populations were founded mostly by people of African descent, but also by Europeans (mostly men) and Amerindians (mostly women).

Though not causal, these haplotypes help clarify demographic history, and hence might help defining guidelines for the diagnostic of CF in admixed populations with complex histories, as well as for focusing the search for pathogenic variants on those most common in a given group.

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### The relationship between pathology and age: diffuse idiopathic skeletal hyperostosis (DISH) in known-age individuals

LAURA CASTELLS NAVARRO and JO BUCKBERRY  
School of Archaeological Sciences, University of Bradford

Diffuse idiopathic skeletal hyperostosis (DISH) is a spondyloarthropathy commonly associated with men over 50 years of age. It therefore has been used as a broad indicator of old age; however its onset and development remains poorly understood. This study aims to understand the relationship between age and DISH. 37 individuals (25 male, 12 female) between the ages of 52 and 89, all previously diagnosed with DISH, were analysed (WM Bass Donated Skeletal Collection).

There was a weak correlation between the number of vertebrae ankylosed and the age of the individual ( $r=0.366$ ;  $p=0.02$ ), due to inter-individual variability. Some individuals show complete ankylosis of the thoracic spine at 55-60 years old and others ankylosis of just 3 or 4-vertebrae at the age of 70. Ankylosis was present in females, but generally for older individuals. The

analysis revealed a weak non-significant correlation between the spinal ankylosis and size of enthesopathies at both patellae, calcanei and left ulna, but a weak significant correlation with the right ulna ( $r=0.338$ ;  $p=0.041$ ). The presence and size of the enthesophytes within and between individuals was very variable, with non-significant negative correlations between age and enthesopathy for both ulnae, calcanei and left patella. A weak negative correlation was observed with the right patella ( $r=-0.388$ ,  $p=0.041$ ).

DISH could be used as indicator of middle-old adulthood, but is not only seen in males over the age of 50. Degree of ankylosis does not relate to age. Finally, extra-spinal manifestations generally show a negative relationship with increasing age in this sample.

### Lordosis variability and shock attenuation in the hominin lumbar spine

ERIC R. CASTILLO and DANIEL E. LIEBERMAN  
Human Evolutionary Biology, Harvard University

Fossil evidence suggests considerable lordosis variability within and between hominin populations. However, interpreting these variations is challenging because the functional consequences of lordosis remain unclear. Although lordosis is crucial for postural stability, a complementary hypothesis predicts that lordosis represents a dynamic compromise between competing viscoelastic demands: the lumbar spine supports the trunk as a rigid, spring-like strut while curvature modulates its capacity to act like a shock absorber, dissipating energy from dynamic loads as bending and rotational deformations. To test this, 27 subjects (14 male, 13 female) walked and ran on a treadmill at 0.25 and 1.00 Froude. 3D kinematics were captured, and small lightweight tri-axial accelerometers were affixed to the back at T12/L1 and L5/S1. Impact shock attenuation in the lumbar spine was analyzed across frequency domains using a power spectral density transfer function. A simple, linear spring-damper model estimated viscoelastic parameters. Results suggest that walking accelerations are not associated with lordosis, but running showed a strong negative correlation with average dynamic and static lordosis ( $r<-0.50$ ,  $p<0.01$ ), which translated to more than 60% of the shock attenuated in the spines of individuals with the greatest lordosis. Multiple regression models revealed that greater shock attenuation was positively associated with lordosis angular displacements (a proxy for stiffness) but negatively associated with angular displacement velocity (a proxy for damping), thus providing support for the viscoelastic hypothesis. These findings may suggest that less lordotic Neanderthal lumbar spines were better adapted for stiffness and stability at the expense of reduced capacity for shock absorption.

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## A retrospective study of age estimation method performance on positively identified forensic cases

CHELSEA C. CATALDO-RAMIREZ, MEGAN J. RUE and HEATHER M. GARVIN

Applied Forensic Sciences, Mercyhurst University

Published accuracy rates for assorted age estimation methods vary among studies, and depend on the samples and statistical information utilized. In this study, we examined the age estimation data that had been collected on 49 real forensic anthropology cases in which the individual was subsequently positively identified. Our goal was to determine which method provided the most accurate and precise age estimates and how accuracy rates vary if the ranges or standard deviations are used to create an age estimate.

Age estimates obtained using Boldsen et al.'s ADBOU software provided high accuracy rates (88.23% correct using the 95% CI), the greatest precisions (average 18.27 year ranges), and minimal age bias. Brooks and Suchey (1990) presented the highest accuracy (100%), although the age estimate ranges were broader (average 35.91 years). For Buckberry and Chamberlain (2002), Meindl and Lovejoy (1985), and İscan (1987), using the mean age +/- two standard deviations (2SD range) instead of the age ranges increased the accuracy rate by 12 to 19% with minimal decreases in precision (average 3.39 to 4.16 additional years). For Osborne (2004), use of the 2SD range improved both accuracy (92.8%) and precision (average 47.86 years). Using the mean age +/- one standard deviation resulted in accuracies between 41.17% (Buckberry and Chamberlain) to 75.8% (Suchey-Brooks). Buckberry and Chamberlain had the highest bias of the methods assessed, with a tendency to overage individuals. Overall, the results suggest that using a multifactorial method, such as ADBOU, can increase the precision of age estimates without compromising accuracy.

## An Investigation of the Inhibitory Cascade Mechanism in Extant and Extinct Lemurs

KIERSTIN K. CATLETT<sup>1</sup>, LAURIE R. GODFREY<sup>2</sup>, KAREN SAMONDS<sup>3</sup>, E. SUSANNE DALY<sup>1,4</sup>, GARY T. SCHWARTZ<sup>1,4</sup> and ALISTAIR EVANS<sup>5</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, USA,

<sup>2</sup>Department of Anthropology, University of Massachusetts Amherst, Amherst, MA, USA,

<sup>3</sup>Department of Biological Sciences, Northern Illinois University, DeKalb, IL, USA, <sup>4</sup>Institute of Human Origins, Arizona State University, Tempe, AZ, USA,

<sup>5</sup>School of Biological Sciences, Monash University, Melbourne, Australia

Control of relative postcanine tooth size proportions has been attributed to an inhibitory cascade (IC) mechanism, where a previously-initiated tooth influences a subsequently-developing tooth through the interaction of molecular activators and inhibitors produced during development. Evans and colleagues found that hominin lower primary postcanine (i.e., deciduous premolars and molars) tooth proportions fit the predictions of the IC model. Compared to hominins, lemurs have rapid dental development (some extremely so, regardless of body size) and exhibit a variety of derived traits (including vestigial deciduous teeth and different eruption sequences). Since the IC model is proposed to be highly constrained across mammals, we test whether the IC model holds in extant and extinct lemurs. Specifically, we test whether tooth size proportions change in a linear fashion within and across the upper and lower primary postcanine teeth.

We measured and analyzed tooth areas of 22 extant and extinct species (N=439). Across the primary postcanine teeth, a linear relationship is rare and the fit of the IC model is variable. For example, we could not predict the size of M<sup>2</sup> given size differences between dp<sup>4</sup> and M<sup>1</sup>, nor could we extrapolate M<sup>3</sup> size given the sizes of M<sup>1</sup> and M<sup>2</sup>. Phylogeny explains much of the variation in dental proportions. Interestingly, across almost all families, the upper postcanine teeth exhibit greater deviations from linearity than the lowers. Lemurs exhibit highly derived dentitions, and this study expands our knowledge of lemur dental evolution.

## Site-specific cortical bone topographic variation across the whole neck assessed in two hominin proximal femora from Swartkrans Member 1, South Africa: SK 82 and SK 97

MARINE CAZENAVE<sup>1,2</sup>, JOSÉ BRAGA<sup>2,3</sup>, FRIKKIE DE BEER<sup>4</sup>, JAKOBUS W. HOFFMAN<sup>4</sup>, ROBERTO MACCHIARELLI<sup>5,6</sup>, ANNA OETTLÉ<sup>1</sup> and JOHN F. THACKERAY<sup>3</sup>

<sup>1</sup>Department of Anatomy, University of Pretoria, South Africa, <sup>2</sup>UMR 5288 AMIS CNRS, Université de Toulouse Paul Sabatier, France, <sup>3</sup>Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa, <sup>4</sup>South African Nuclear Energy Corporation, Pelindaba, South Africa, <sup>5</sup>UMR 7194 CNRS, Muséum national d'Histoire naturelle, Paris, France, <sup>6</sup>Unité Formation Géosciences, Université de Poitiers, France

Compared to the ape condition, extant and fossil humans show a distinctly asymmetric cortical bone distribution pattern across the femoral neck, with thinner superior (S) and thicker inferior (I) cortex. Such functionally-related arrangement also variably characterizes australopithecines. However, bone structural variation across the

anterior (A) and posterior (P) aspects of the neck remains unreported in fossil hominins.

We used micro-focus X-ray tomography to detail site-specific bone topographic arrangement in two Early Pleistocene proximal femora from Swartkrans Member 1, South Africa, commonly attributed to *Paranthropus robustus* and likely representing two adult male individuals: SK 82 and SK 97.

Acquisitions (isotropic voxel size: 70 µm) were performed at Necsa, Pelindaba. The locally shaded structural signal resulting from consolidated sedimentary infill and micro-cracking was enhanced by techniques of virtual imaging allowing assessment of a nearly uninterrupted lateromedial record in each percentage slice of the neck length. For comparative purposes, we also detailed 12 extant human (EH) femora.

While absolute values differ, our refined S/I measurements support previous CT-based estimates (Ruff and Higgins, 2013) and confirm that asymmetry in both specimens is expressed to a slightly lower degree than usually recorded in EH. However, while cortical bone in SK 82 and SK 97 is absolutely thicker at all sites, both specimens nonetheless reveal (i) a trend of lateromedial S/I increase and (ii) a A/P distribution pattern both shared with our EH comparative sample. The latter evidence is relevant for evaluating the degree of adaptation in hominins to superoinferior bending loads at this skeletal site.

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## The Effects of Lifestyle Factors and Social Support on Physical Activity Patterns among Older Adults from Uganda: Preliminary Analyses from WHO's SAGE-PA Uganda Sub-study

TARA J. CEPON-ROBINS<sup>1</sup>, MONICA KUTEESA<sup>2</sup>, TYLER M. BARRETT<sup>3</sup>, JOSEPH MUGISHA<sup>2</sup>, ELIZA HALLETT<sup>4</sup>, JOSHUA SCHROCK<sup>4</sup>, LOUISE GEDDES<sup>2,5</sup>, PELEGRINO MBABAZI<sup>2</sup>, PAUL KOWAL<sup>4,6</sup>, JANET SEELEY<sup>2,7</sup> and J. JOSH SNODGRASS<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of Colorado Colorado Springs, <sup>2</sup>Medical Research Council/Uganda Virus Research Institute, Uganda Research Unit on AIDS, <sup>3</sup>Department of Anthropology, Northwestern University, <sup>4</sup>Department of Anthropology, University of Oregon, <sup>5</sup>School of Public Health, University of Sydney, <sup>6</sup>World Health Organization, World Health Organization, <sup>7</sup>London School of Hygiene and Tropical Medicine, London School of Hygiene and Tropical Medicine

The World Health Organization's Study on global AGEing and adult health (SAGE) examines the aging process and related health changes in older adults (50+ years) around the world. A major lifestyle change associated with aging is decreased physical activity. We examined data

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from the physical activity sub-study (SAGE-PA) conducted in Uganda in 2013. Physical activity data were collected using ActiGraph GT3X accelerometers worn by 168 participants (71 men, 97 women) over 7 days. Associations between age, sex, lifestyle, and physical activity measures were examined to understand which factors mitigate decreased physical activity with age. We hypothesized that lifestyle factors like socioeconomic status, social support, and engagement in social activities would have significant effects on physical activity based on age and sex. Age was negatively correlated with activity energy expenditure (AEE) in men ( $p < 0.001$ ) and women ( $p < 0.001$ ). Women in this study were significantly younger than men ( $p < 0.05$ ), so One-Way ANCOVAs controlling for age compared AEE between sexes, finding no significant differences. While AEE was not correlated with age in women who were married, it was negatively correlated with age in women who were divorced/separated ( $p = 0.01$ ) and widowed ( $p < 0.001$ ). The reverse was true for men, with married men showing negative correlations between AEE and age ( $p < 0.01$ ). These preliminary analyses suggest that marital status, a measure of social support, differentially affects physical activity based on age and sex. Further analyses examine relationships between physical activity and other lifestyle factors.

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### Macroscopic, microscopic and molecular biomarkers for age estimation: The role of environmental factors

ANDREW T. CHAMBERLAIN

School of Earth and Environmental Sciences, University of Manchester

Inaccuracy in the estimation of age from the adult skeleton arises from individual and population variation in processes of skeletal ageing that can be attributed, at least in part, to the effects of environmental and genetic factors. The influence of these factors gives rise to reduced correlations between the expression of skeletal indicators ('age biomarkers') and chronological age, and may also be responsible for variation between populations in patterns of age-related change in the skeleton. Here I review the evidence for the effects of environmental factors on macroscopic age markers in the pelvic joint surfaces, microscopic markers in cortical bone and the dentition, and molecular markers in skeletal protein and DNA. The macroscopic markers (acetabulum, auricular surface and pubic symphysis) have the lowest correlations with age, typically in the range  $r = 0.4$  to  $0.6$ , and appear to show the largest potential influence of environmental variables, especially of body size. Microscopic markers tend to show higher correlations with age, typically  $r =$

$0.5$  to  $0.9$ , as well as less variation between populations in the relationship between biomarkers and chronological age. Nevertheless, significant effects of body size and diet on bone remodelling have been reported in some studies. Molecular biomarkers have the highest correlations with age (usually  $r > 0.7$ ) but some effects of disease and immunity and of drug use history on age-related molecular changes have been detected. Much of this evidence has been acquired within the last decade and further research on a wider range of biomarkers is needed.

### Biological sex assessment methods: A meta-analysis of trends in recent (2006-2015) forensic and archaeological research

AVERY B. CHECK and ELIZABETH CRAIG-ATKINS  
Department of Archaeology, University of Sheffield

Biological sex assessment methods are integral to human identification and productive forensic and archaeological research. Given the differing agendas of forensics and archaeology, the aim of this study was to evaluate the potential for greater collaboration between these fields in developing sex assessment methods and to highlight the most fruitful lines of research to target in future studies.

This review utilized statistical analyses, examining data from five major journals, to assess the nature of sex assessment methods research in recent (2006-2015) forensic and archaeological publications. The way in which error was reported, anatomical regions of study, populations studied, types of study (revised, refined, testing, or comparison), and approaches (morphological, metric, biomedical, three-dimensional, or molecular) were all considered.

The results of these topics were presented hierarchically according to the importance of the findings. There was a deficit in standardized measures of error and accuracy in both fields. The skull, an anatomical region purported to be the second most accurate in sex assessment, was most studied. However, it yielded the lowest overall reported percentage of accuracy. The testing of published methods was lacking in both fields. Bias towards certain populations was evident in developing sex assessment methods, which demands greater collaboration between archaeology and forensics. Lastly, archaeology and forensics both favored metric approaches. Molecular approaches were more prevalently used in published archaeological research. These results will guide the organization of future biological sex assessment studies to fill these gaps in recent research.

### New primitive micromomyid plesiadapiform from the Wutu Formation, Shandong Province, China

STEPHEN G. B. CHESTER<sup>1,2,3</sup>, K. CHRISTOPHER BEARD<sup>4,5</sup>, YONGSHENG TONG<sup>6</sup>, XIJUN NI<sup>6</sup> and JINGWEN WANG<sup>6</sup>

<sup>1</sup>Department of Anthropology and Archaeology, Brooklyn College, City University of New York, <sup>2</sup>Department of Anthropology, The Graduate Center, City University of New York, <sup>3</sup>New York Consortium in Evolutionary Primatology, NYCEP, <sup>4</sup>Biodiversity Institute, University of Kansas, <sup>5</sup>Department of Ecology & Evolutionary Biology, University of Kansas, <sup>6</sup>Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences

Micromomyid plesiadapiforms are diminutive euarchontan mammals previously known only from the late Paleocene and early Eocene of western North America. We describe the first potential Asian record for this clade, based on a partial dentary from the Wutu Basin in east-central China. IVPP V11990 is a right dentary fragment preserving the crowns of p2 (partial), p3-4, m2 (taloid), and m3. The lower dental formula and certain aspects of the lower anterior dentition remain ambiguous because of breakage. Among plesiadapiforms, the new Chinese taxon resembles micromomyids in being very small and having a hypertrophied p4 trigonid with a fairly developed taloid. However, it is more plesiomorphic than any known micromomyid in lacking a trenchant p4 paracristid, which has traditionally been used to diagnose the North American members of this family. Among micromomyids, the Wutu taxon most closely resembles the oldest known species, *Foxomomys fremdi*, from the middle Tiffanian (Ti-3) of Alberta, Canada, in possessing a relatively small and narrow p3, a relatively narrow p4, and tall trigonid cusps and a slightly enlarged, yet cuspidate hypoconulid on m3. Phylogenetic analysis reconstructs the new Chinese taxon as the basal-most member of the Micromomyidae and provides further support for a rather basal position for Micromomyidae among plesiadapiforms. Although the age of the Wutu fauna remains controversial (late Paleocene or early Eocene), this specimen further documents trans-Beringian plesiadapiform dispersal during or before the Tiffanian and suggests that important aspects of early plesiadapiform evolution are inadequately sampled in the Paleocene of Asia.

This study was funded by NSF grant BCS-0820602 to K.C.B. and a PSC-CUNY Award to S.G.B.C.

### Zika, Maternal Stress and Prematurity in Puerto Rico: Navigating Unforeseen Vulnerabilities

MELISSA CHEYNEY and HOLLY HORAN  
Anthropology, Oregon State University

This poster describes work in Puerto Rico with pregnant women at risk for Zika-affected offspring, prematurity and low birth weight. Our

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project was designed to investigate the biocultural production of maternal stress in a US territory/colony, and to determine whether and to what extent maternal stress contributes to the high rate of preterm birth in Puerto Rico. Data collection on the ground highlights the ways both researchers and IRB reviewers mis-anticipated points of vulnerability and agency among potential study participants. Specifically, we explore participants' perspectives on vulnerability to Zika, prematurity and poverty as neocolonial disorders. We argue that concepts of "saved lives" or "babies saved" obscure the power dynamics that create vulnerabilities related to Zika and prematurity to begin with. We can then better understand the irony with which potential participants read consent documents aimed at "minimizing risks" related to research. Human subject protections, within the larger context of neocolonial disorders, expose what one participant called "double exploitation" whereby US policies create diseases or conditions that US researchers can then build lucrative academic careers studying. How do we as researchers acknowledge and respond to these types of difficult moments we measure and document, while creating opportunities for improvements in the lives of our participants? How are we complicit in creating the conditions of psychosocial stress and suffering we then receive grants to study?

*This project is funded by the National Science Foundation (Award ID 1628643).*

### Age and Sex-related Changes in Cross-Sectional Geometry in a 17<sup>th</sup>-19<sup>th</sup> Century Rural Dutch Population

CELISE CHILCOTE<sup>1</sup>, ANDREA L. WATERS-RIST<sup>2</sup>, MENNO LP. HOOGLAND<sup>2</sup> and SABRINA C. AGARWAL<sup>1</sup>

<sup>1</sup>Anthropology, University of California, Berkeley,  
<sup>2</sup>Faculty of Archaeology, Leiden University

Clinical and osteological studies have provided evidence that patterns in long bone cross-sectional geometry can be correlated with general patterns of activity. This study presents preliminary results of a larger research project examining social identity over the life course in the historic dairy farming community of Middenbeemster, NL, through the examination of long bone diaphyseal cross-sectional geometry to infer differing sex and age-related patterns of activity and workload. It was hypothesized that the high demand for Dutch dairy product exports during the 18th and 19th centuries would be reflected in the variability of limb bone strength and shape, suggesting age/sex specific workloads, for the historic population of Middenbeemster. Long bones, especially those of the upper limb, are prone to influences by habitual activities; therefore CT scans of both humeri and a femur of 88 adults (m=46, f=42) were taken in order to ascertain the diaphyseal structure and cross-sectional

properties (including: second moments of area, the total subperiosteal area, medullary area and cortical area) of each long bone. After controlling for body size, statistically significant differences in upper limb activities between the sexes as well as in lower limb activities between different age groups were found, suggesting workloads divided by both age and sex. Combined analyses of the data with archival records on this historic community, provide a unique opportunity to examine and interpret patterns of activity related markers over the life course.

### Genome-wide epigenetic signatures of high-altitude adaptation in Peru

AINASH CHILDEBAYEVA<sup>1,2</sup>, DANA C. DOLINOY<sup>2</sup>, JACLYN M. GOODRICH<sup>2</sup>, MARIA RIVERA-CHIRA<sup>3</sup>, FABIOLA LEON VALERDE<sup>3</sup>, MELISA KIYAMU<sup>3</sup>, TOM BRUTSAERT<sup>4</sup> and ABIGAIL W. BIGHAM<sup>1</sup>

<sup>1</sup>Anthropology, University of Michigan,  
<sup>2</sup>Environmental Health Sciences, University of Michigan,  
<sup>3</sup>Departamento de Ciencias Biológicas y Fisiológicas, Universidad Peruana Cayetano Heredia,  
<sup>4</sup>Exercise Science, Syracuse University

High-altitude adapted individuals show distinct circulatory, respiratory, and hematological adaptations to chronic hypoxia. Emerging genetic data support an evolutionary origin and a genetic basis for these observed physiological adaptations to high altitude. However, the epigenetic contribution to adaptation to hypobaric hypoxia has not been well characterized. We performed a genome-wide Illumina MethylationEPIC array on 28 whole-blood samples from individuals of Quechua ancestry living in Peru. We performed a differential methylation analysis of the samples between a group born-and-raised at high altitude and a group born-and-raised at low altitude. After data normalization, we found > 200 differentially methylated CpG sites between our groups at false-discovery rate cutoff 0.05. DAVID analysis revealed that these sites correspond to signaling regulation, signaling transduction, cell division, and other pathways. Our results illustrate that high altitude likely imbues lasting effects on the epigenome and contribute to our understanding of the ways in which the human organism responds and adapts to the environment.

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### Geometric Morphometric and Craniometric Analysis of the MidFace in Colombian Population. Allometry and Sexual Dimorphism

SHAYRA O. CHINÁS<sup>1</sup>, MARÍA E. PEÑA<sup>2,3</sup>, CÉSAR SANABRIA<sup>3</sup> and LOURDES MÁRQUEZ<sup>4</sup>

<sup>1</sup>Physical Anthropologist, Escuela Nacional de Antropología e Historia, <sup>2</sup>Physical Anthropologist, Escuela Nacional de Antropología e Historia, Instituto

Nacional de Antropología e Historia, <sup>3</sup>Branch of Scientific Research, Instituto Nacional de Medicina Legal y Ciencias Forenses, <sup>4</sup>Physical Anthropologist, Escuela Nacional de Antropología e Historia

Discrimination of sexual dimorphism is of importance in forensic identification. It is also necessary to describe the association shape and size by sex within a population. The purpose of this paper is to establish the relationships of allometric changes and sexual dimorphism at the midface section on a collection of skeletons with known age at death. We depart from the assumption that variation in shape at midface is largely dependent on size and less influenced by sex. Data were collected on 159 male and female individuals from the Human Bone Collection Colombian Population Reference of Bogota, the National Institute of Legal Medicine and Forensic Sciences. Three-dimensional coordinates of 27 standard craniofacial landmarks were collected using a Microscribe digitizer, and six absolute dimensions collected by ThreeSkull. Discriminant analysis was used to describe form and sex relationships. The shape and size analysis was based on linear regression through MorphoJ Software. ANOVA a factor for sex and age, was used for craniometric analysis. Results for absolute dimensions corresponds to findings by the geometric morphometric. The main results at the midface are: bizygomatic width, shows clear dimorphism. The palate width trend with age is to be reduced, probably associated with tooth loss and bone resorption. While the nasal width did not differ by sex. The results of this study support the observation of combined effects on size and sex in the shape of the form of the midface.

*National Council for Science and Technology*

### Assessment of the Thoracolumbar Transition in Modern Humans

ELIZABETH O. CHO<sup>1</sup>, THIERRA K. NALLEY<sup>2</sup>, EMILY R. MIDDLETON<sup>3</sup> and CAROL V. WARD<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Missouri, <sup>2</sup>Department of Medical Anatomical Sciences, College of Osteopathic Medicine of the Pacific, Western University of Health Sciences, <sup>3</sup>Department of Pathology and Anatomical Sciences, University of Missouri

The location and morphology of the thoracolumbar transition is of evolutionary and clinical interest due to its role in spinal stability and flexibility. Commonly found in modern humans at T12, the transition appears to be displaced cranially in early hominins. The functional relevance of this variation in reference to bipedality and species comparisons has been clouded by differing vertebral definitions and inconsistent criteria for determining transition type (gradual versus abrupt) in modern humans. Thoracolumbar junction morphology predisposes modern humans to spinal injuries, with individuals exhibiting an abrupt transition at greater risk. Published

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studies tend to quantify this transition by considering facet orientation or curvature, despite the fact that this transition involves both aspects of joint morphology, and that both potentially affect function. This study examined both the curvature and orientation of facets in a large sample (N=170) of modern humans from the Hamman-Todd osteological collection. All specimens were adult, and the sample included relatively even distribution of sex and ancestry. Vertebrae T9-L3 were photographed in cranial view. Landmarks were set on the midline and facet margins, with semilandmarks distributed along each cranial zygapophyseal facet. Procrustes and principle components analysis show that roughly half of the individuals exhibiting a gradual transition. Facet orientation and curvature generally change together moving caudally across the transition. Additionally, changes in facet orientation tend to coincide with or precede facet curvature. The findings of this study emphasize the importance of considering facet orientation and curvature in tandem to characterize the thoracolumbar transition.

*The Leakey Foundation*

### Applications of bone histomorphometry in bioarchaeology, forensic anthropology, and clinical studies

HELEN CHO

Anthropology, Davidson College

Sam Stout's methodologies and advancements in histomorphometry and histomorphology continue to be have important applications in human skeletal biology. This presentation will discuss existing and new techniques that were developed by Stout and colleagues. Estimation of bone remodeling dynamics in diverse archaeological populations from the US to Italy to Egypt have elucidated our understanding of the universal phenomenon of age-associated bone loss and ancient skeletal health. The same theoretical framework and algorithms to deduce bone turnover rates in the past are imperative to understanding the sex differences and inter-population variation in bone loss; contemporary populations are more vulnerable to osteopenia and osteoporosis due to increased longevity and various lifestyle factors. Furthermore, histological methods enhance the available techniques for age-at-death estimation of adult and subadult individuals in addition to distinguishing human from non-human bone in medicolegal cases. The application of histomorphometry in forensic anthropology has led Stout and his research collaborators to develop numerous age-at-death estimation methods in extreme fragmentation cases where standard anthropometric approaches are inapplicable. Stout et al.'s novel approaches to investigating skeletal tissue include various types of microscopy instrumentation including 3D reconstruction of bone

microstructures, employing histology as a tool to examine metabolic and systemic skeletal disorders, and biomechanics of bone microstructure.

### A theoretical demonstration for the effects of anthropometric secular changes relative to military accommodation rates among different race groups

HYEG JOO CHOI, TODD N. GARLIE, JOSEPH PARHAM, J. DAVID BRANTLEY and STEVEN P. PAQUETTE

Anthropology, US Army Natick Soldier Research Development and Engineering Center (NSRDEC)

Accommodation rates (90%, 95%, or 98%) used in the US Army vary depending on the type of clothing and equipment and this can significantly influence the overall dis-accommodation rates of the user population. The 1<sup>st</sup>, 2.5<sup>th</sup>, 5<sup>th</sup>, 95<sup>th</sup>, 97.5<sup>th</sup>, and 99<sup>th</sup> percentiles represent the minimum and the maximum critical values for the military user population accommodation for acquisition of military clothing and equipment (CIE) and personal protective equipment (PPE). Beyond these critical values are the proportion of the current personnel in the Army population excluded from adequate equipment design and prototyping. The assumption for this study is that the accommodation rates (90%, 95%, or 98%) should be applied evenly among all population groups relative to DOD race categories in the US Army. Thus, regardless of accommodation rate, the accommodated and dis-accommodated proportion of each population group should be consistent with its population proportion relative to the total Army. This study demonstrates theoretically whether this assumption is appropriate. Results from this evaluation suggest that setting specific boundaries may exclude individuals differently based upon population origin and thus affect the fit of CIE, PPE and the usability of military workspaces. Understanding these unequal distributions in body size for male and female Army personnel and differing population groups is critical for developing design parameters in CIE/PPE for the Army. If certain sectors of the Army population are dis-accommodated, then poorly fitting CIE/PPE can introduce increased risk to the Soldier through decreased protection levels and decreased performance levels.

### Coping with Death: Behavioral Mitigation of the Loss of an Alpha Male by Female Chacma Baboons in South Africa

SHAHRINA CHOWDHURY<sup>1,2,3</sup> and LARISSA SWEDELL<sup>1,2,3,4</sup>

<sup>1</sup>Anthropology, Graduate Center, City University of New York, <sup>2</sup>Primatology, New York Consortium in Evolutionary Primatology, <sup>3</sup>Anthropology, Queens College, <sup>4</sup>Archaeology, University of Cape Town

Changes in male demography and rank can be disruptive to social groups and are known to

negatively impact female baboon physiology. The death of an alpha male and ensuing social instability, for example, may have negative consequences in the form of heightened stress levels, as expressed in higher levels of glucocorticoid concentrations. Females may cope by modifying their social relationships depending on their reproductive state. Here we study the effects of the death of the alpha male on 16 adult females in a troop of chacma baboons in the Cape Peninsula of South Africa. The male who had been alpha for >8 months sustained severe injuries and died a month later; during this interim period he stayed only intermittently with the troop. We examined the effects of his death by comparing female behavior and physiology across three periods: the 3-month period before injury, the month during which he remained alive with injuries, and the 3-month period following his death. Contrary to our expectations, fecal glucocorticoid concentrations for females were lower in the periods following injury and death (F=4.041, df=2, p=0.018), with pregnant females experiencing the least (4%) and lactating females the greatest (16%) decline. Interestingly, during the interim period, females dramatically increased grooming of females (except swollen) and males (except pregnant), and all females spent more time grooming other females after his death. These results suggest that the adjustments females made to their grooming behavior were a coping mechanism that effectively mitigated the negative physiological impact of the social instability.

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### An Inside View: Childhood Stress at the Greek Colony, Himera

MELISSA CHOWNING<sup>1</sup>, CAREY GARLAND<sup>2</sup>, BRITNEY KYLE<sup>1</sup>, STEFANO VASSALLO<sup>3</sup> and LAURIE J. REITSEMA<sup>2</sup>

<sup>1</sup>Anthropology, University of Northern Colorado, <sup>2</sup>Anthropology, University of Georgia, <sup>3</sup>Regional Archaeological Superintendence of Palermo, Italy

This study addresses early life stress indicated by internal incremental growth lines of human dental remains from the 7-5<sup>th</sup> c. BC colony of Himera. Co-occurrence of flexed and supine interment styles at Himera hint at intrapopulation cultural differences in this multi-ethnic colony site. To examine whether these cultural differences are related to differences in health, we test two null hypotheses: that there are no significant differences in prevalence (number of individuals affected) of Wilson bands between supine and flexed burials, and that there are no significant differences in the number of Wilson bands per individual between supine and flexed burials. Canines from 26 adult skeletons were

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thin-sectioned and microscopically analyzed for evidence of accentuated internal striae of Retzius (Wilson bands; WB), which are indicative of non-specific childhood stress. 82% of supine ( $n=10$ ) and 94% of flexed ( $n=16$ ) skeletons exhibited WB (chi-square;  $p=0.360$ ). The mean number of WB in canines from supine burials is 3.5 and for flexed burials is 6.3 ( $p=0.097$ ). Overall, WB prevalence increases as age at death increases, suggesting individuals who survived childhood stress were more likely to live longer. The lack of statistical significance in WB between burial styles supports our null hypothesis, suggesting childhood stress of these individuals was similar despite differences in how they were buried. However, a larger sample size is needed to further explore the observation that flexed individuals experienced stress slightly more often. More research is needed to fully understand the cultural significance burial style variation at Himera.

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### Associations between *MHC-DQA1* Regulatory Variation and the Gut Microbiome in the Ugandan Red Colobus (*Procolobus rufomitratus tephrosceles*)

DIANA M.C. CHRISTIE<sup>1,2</sup>, NOAH D. SIMONS<sup>1</sup>, MARIA JOSE RUIZ-LOPEZ<sup>2</sup>, COLIN A. CHAPMAN<sup>3,4</sup>, TONY L. GOLDBERG<sup>5,6</sup>, KEATON STAGAMAN<sup>2</sup>, BRENDAN J.M. BOHANNAN<sup>2</sup> and NELSON TING<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Oregon, <sup>2</sup>Institute of Ecology and Evolution, University of Oregon, <sup>3</sup>Department of Anthropology, McGill University, <sup>4</sup>School of Environment, McGill University, <sup>5</sup>Department of Pathobiological Sciences, University of Wisconsin-Madison, <sup>6</sup>Wisconsin National Primate Research Center, University of Wisconsin-Madison

Variation in the gut microbiome has been linked to a variety of health and disease concerns. However, the extent to which host genetic factors affect inter-individual variation in gut microbial communities of wild non-human primates is unclear. We addressed this question in the Ugandan red colobus monkey, by testing for associations between gut microbial composition and regulatory variation in *MHC-DQA1* – a gene highly expressed in the gut lumen and known to interact with bacterial proteins. We characterized gut microbial communities across a social group of red colobus from Kibale National Park, Uganda via 16S rRNA barcoding of the V4 hypervariable region. We identified one SNP in the *MHC-DQA1* core promoter that was associated with both lower alpha diversity (measured via Shannon Index) and species richness ( $p < 0.05$ ,  $p < 0.001$  respectively). Two more SNPs were significantly associated with beta diversity dissimilarity in gut microbial communities (measured via Canberra and UniFrac distance). These SNPs represent candidate loci for further functional testing to

determine the extent to which they drive differential expression of *MHC-DQA1*. In addition, host sex explained a significant amount of variation in gut microbial communities, and further exploration is needed to determine whether hormonal, genetic or behavioral differences between male and female individuals is the driving factor behind sex-biased microbial diversity and composition. We conclude that differences in expression of immune-related genes may play a small but significant role in shaping the variation we see in the gut microbiome of the Ugandan red colobus monkey.

### Patch-use Decisions in Geladas: Effects of Body Size and Food Type

LAUREN CHRISTOPHER<sup>1</sup>, VIVEK V. VENKATARAMAN<sup>1</sup>, JEFFREY T. KERBY<sup>2</sup>, NGA NGUYEN<sup>3</sup> and PETER J. FASHING<sup>3</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University, <sup>2</sup>Biological Sciences, Dartmouth College, <sup>3</sup>Anthropology, California State University - Fullerton

Animals must navigate various ecological and physiological constraints to achieve their foraging goals. Metabolic theory predicts that intake rate should scale with body size. However, because diet quality varies with body size and resources are heterogeneously distributed, behavioral solutions for achieving foraging goals are likely to vary. We examined these issues in gelada monkeys by studying energy intake rates and patch departure decisions at short timescales. Geladas are manual grazers who shuffle or walk between feeding patches, rapidly collecting grasses and herbs. At the Guassa Plateau in northern Ethiopia, we observed ~154 geladas feeding on a range of foods ( $n = 2700$  bouts) and used nutritional data to estimate instantaneous energy intake rates at feeding patches. Our results indicate that feeding behavior in patches differs according to body size and food type. The gain functions (energy acquisition through time in a patch) are best described by asymptotic exponential curves, and the slope and height of these curves increase with body size. Moreover, juveniles depart patches sooner because they feed in smaller patches of higher quality resources (e.g., herbs). Finally, patch departure decisions are associated with evidence of resource depletion, suggesting that geladas can detect the marginal value of patches.

### Patterns of mtDNA Diversity in Central Asia Reveal a Complex Population History

BONNY M. CHRISTY  
Anthropology, Texas A&M University

From a genetic perspective, Central Asia is one of the least studied areas of the world. The research that has been done thus far in the region has shown that Central Asian populations exhibit a high degree of genetic diversity, but the reasons for this diversity and the processes that

have shaped it have not been fully explained. To address this gap, complete mitochondrial (mt) genomes (2,277) and mt control region sequences (4,392) from Central Asia and the surrounding regions (Caucasus, East Asia, East Europe, Near East, North/Northeast Asia, and South Asia) sourced from GenBank were analyzed. The high genetic diversity in Central Asia has been explained as either the result of an incubation phase of Eurasian genetic variation prior to a split toward east and west, or the result of admixture between differentiated east and west Eurasian populations. To further explore this question, measures of genetic diversity were calculated and haplotypes were identified for all mtDNA sequences. Similar to previous results, high nucleotide and haplotype diversity were found in Central Asia. However, there were no unique haplotypes identified in the region. These results suggest that Central Asia has been a crossroads where populations from east and west Eurasia have interacted with one another because of migrations, trade, and warfare.

### The functional significance of iliac buttressing in the genus *Homo*

STEVEN E. CHURCHILL  
Evolutionary Anthropology, Duke University, Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand

Robusticity of the iliac acetabulosacral and acetabulocrystal buttresses is variable in both fossil and recent members of the genus *Homo*, but is generally greater than observed in fossils of *Australopithecus*. Variation in iliac buttress robusticity may reflect variation in lateral flare of the iliac blades, since a more lateral position of the gluteal abductors might be expected to better attenuate bending moments in these structures during the support phase of walking. Alternatively, iliac buttress robusticity may vary with body size or (in the case of the acetabulocrystal buttress) with the degree of sigmoid curvature of the iliac crest. To explore the interplay of size, iliac blade morphology, and iliac buttressing within modern humans, measures related to body size, iliac flare, iliac crest shape, and robusticity of the acetabulosacral and acetabulocrystal buttresses were collected on the ilia of 52 female and 51 male southern African adult skeletons. Relationships between variables were explored by PCA using log-transformed and geometric mean-standardized shape variables.

The PCA identified three major components accounting for 46.2%, 16.5%, and 11.4% of the total variation in the data, respectively. The first component largely accounts for variation in lateral iliac flare, with minimal contribution from measures of either buttress. The second and third component reflect robusticity in the acetabulosacral and acetabulocrystal buttresses,

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respectively, with moderate-to-low loading of all other variables. Although size may explain some variation in iliac buttressing, results suggest that among recent humans this variation is largely independent of variation in lateral iliac flare and iliac crest shape.

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### Reconstructing the monastic lifestyle: Bioarchaeological investigation of living conditions in a religious community based on human skeletal remains from el-Ghazali, Sudan

JOANNA A. CIESIELSKA<sup>1</sup> and ROBERT J. STARK<sup>2</sup>

<sup>1</sup>Institute of Archaeology, University of Warsaw,

<sup>2</sup>Faculty of Anthropology, McMaster University

Ghazali, located in Northern Sudan ~20 km west of the modern city of Karima, is a medieval monastery (ca. 7<sup>th</sup>–13<sup>th</sup> c. AD) with three associated cemeteries and a small village. Based on its location adjacent to the monastic edifices, combined with the demography of the excavated burials (97% of the deceased are adult males), Cemetery 2 is believed to be the burial place of the monks inhabiting this site. The physical realities of monasticism in Nubia remain poorly understood with limited texts and archaeological data on monastic complexes being the main avenues of inquiry. Bioarchaeological investigation of over 100 graves from Cemetery 2 has provided us a means of examining the nature of life in this desert environment at the northern fringes of the Bayuda desert. At Ghazali, analysis of human skeletal remains provides an important complement to the interpretation of living conditions inferred from archaeological data. Individuals interred in Cemetery 2 appear generally healthy, with osteoarthritis in the vertebrae being the most consistently present pathological condition. Dental health of the deceased is highly variable. Most individuals have little dental pathology, with caries being the most common, while at least two individuals exhibit severe alveolar osteolysis resulting in perforation of the maxillary sinus. Two cases of unhealed hip fractures as well as a severe case of discitis have also been observed. This contextual cemetery population study provides a quantitative look at the implications of desert asceticism on the pathological experience of a group of Nubian monks.

*Project is funded by Qatar-Sudan Archaeological Project and Polish Centre of Mediterranean Archaeology, University of Warsaw.*

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### Mortality Effects of Discrimination in Post-Medieval Ireland

MELISSA A. CLARK

Anthropology, The Ohio State University

The political and religious conflict between Catholics and Protestants in modern Ireland that led to a series of civil wars and ultimately the separation of the region into two countries

developed, in part, as a product of the institutionalization of the Penal Laws (1690-1829). Historians have argued that because these laws were rarely enforced, the perceived victimization of Irish Catholics under the Penal laws was more a product of nineteenth and twentieth-century nationalism than the effects of the laws themselves. However, others have argued that the Penal Laws were unusually cruel with devastating effects. Thus, the true impacts of the Penal Laws remain unknown. This study investigates the impacts of the Penal Laws by exploring the differential mortality of Catholics and Protestants in post-Medieval, pre-famine Ireland. In an online review of burial records from *Ireland, Burial Index, 1600-1927*, birth and death dates were identified for individuals interred in Catholic (n=2344) and Protestant (n=1356) cemeteries in Dublin between 1810 and 1830. Results from a Mann-Whitney U test show that individuals buried in Catholic cemeteries (mean age= 31.16) were more likely to experience earlier mortality than those buried in Protestant cemeteries (mean age=36.51) (p<0.0001). These results suggest that the discrimination faced by Irish Catholics during the Penal era had long-term biological consequences.

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### Considering Vulnerability in War-affected and Forcibly Displaced Populations

PATRICK F. CLARKIN

Anthropology, UMass Boston

Biological anthropologists and human biologists can learn a good deal from living populations who have experienced conditions related to war and/or forced displacement. Such environments present multiple challenges and stressors for human biology and health (loss of resources and social support, infection, physical trauma, malnutrition, psychological stress, etc.), the effects of which may last for decades. Ideally, affected populations should benefit from understanding the prevalence, severity, and mechanisms that such stressors can become embodied.

However, forcibly displaced and war-affected populations are also highly vulnerable and often find themselves in situations with reduced agency and compromised protection. This presentation will consider case studies in past and current war-affected populations, with particular focus on former refugees from Southeast Asia, and weighing the potential benefits of research, as well as ethical considerations, protections, and involvement of the people being studied.

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### Optimism and Social Support Buffer Effects of Childhood Disadvantage on Adult Health Behaviors

ELIZABETH S. CLAUSING<sup>1</sup>, JORGE C. ROMÁN<sup>2</sup>, STEPHEN E. GILMAN<sup>3,5</sup>, ERIC B. LOUCKS<sup>4</sup>,

STEPHEN L. BUKA<sup>4</sup>, LAURA D. KUBZANSKY<sup>5</sup>, ALLISON A. APPLETON<sup>6</sup> and AMY L. NON<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of California, San Diego, La Jolla, CA, <sup>2</sup>Department of Math and Statistics, San Diego State University, San Diego, CA, <sup>3</sup>Health Behavior Branch, Division of Intramural Population Health Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development, <sup>4</sup>Department of Epidemiology, Brown University School of Public Health, Providence, RI, <sup>5</sup>Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, <sup>6</sup>Department of Epidemiology and Biostatistics, University at Albany School of Public Health, Rensselaer, NY

Optimism and social support have been shown to reduce risk of cardiovascular diseases, potentially through a pathway of improved health behaviors. However, it is unclear whether these positive psychosocial assets may also buffer the effects of an adverse childhood. Using prospective data (n's ranging from 692-925) from a subset of offspring born to participants in the Collaborative Perinatal Project, a US birth cohort established in 1959-1966, we investigated if positive psychosocial factors in adulthood, such as optimism and social support, interact with childhood disadvantage to affect behavioral outcomes in adulthood, including smoking, drinking, diet, exercising, and BMI. An index of social disadvantage was constructed using information about adverse socioeconomic and family stability factors experienced before age seven. Regardless of the level of childhood adversity, we found higher levels of optimism were significantly associated with higher odds of healthier behaviors, including having a healthy BMI (OR=1.28; 95%CI=1.01-1.64), a prudent (relative to Western) diet (OR=1.50; 95%CI=1.20-2.21), and not smoking (OR=1.76; 95% CI=1.40-2.21); all p-values <0.043. Adults with more social support also had higher odds of having a healthy BMI score (OR=1.46, 95%CI=1.011-2.13), a prudent diet (OR=2.06, 95%CI=1.48-2.92), and not smoking (OR=1.85, 95%CI=1.37-2.52); all p-values<0.048. Overall, positive assets were associated with higher odds of healthier behaviors for all levels of childhood adversity, though associations were stronger among those who experienced low relative to high adversity in childhood, for most outcomes. These findings highlight the importance of positive psychosocial factors, which may buffer the health consequences of an adverse childhood throughout life.

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## ABSTRACTS

### Micro-CT Evaluation of Femoral Neck Cortical Distribution in South African Fossil Hominins

ALEXANDER G. CLAXTON<sup>1</sup> and KRISTIAN J. CARLSON<sup>2</sup>

<sup>1</sup>Anthropology, Boston University, <sup>2</sup>Cell and Neurobiology, Keck School of Medicine, USC

The distribution of cortical bone in the femoral neck has been used to infer locomotor habits in fossil hominins. East African australopiths have been reported to have a modern-human-like femoral neck, with a thin superior and thicker inferior cortex (small S/I ratio). The australopith femora from Sterkfontein and Swartkrans have also been interpreted as being relatively human like, but with larger S/I ratios on average and thicker cortical bone overall. We compared those South African fossils with newer finds of fossil hominins from Malapa and Naledi and with modern humans/apes of comparable age, using a novel method of measurement applying Kernel Density Estimation to micro-CT images. Our data confirm previous descriptions of the Sterkfontein and Swartkrans femora. We find that the S/I ratio of the Dinaledi subadult resembles those of similarly aged modern humans; but in size-controlled superior thickness, it falls in the overlap between the ape and modern-human distributions. The Dinaledi adult S/I ratios are human-like, but the superior cortical thickness is elevated and more australopith-like. The MH1 subadult groups with apes in both of these measures. The MH2 adult has very thick cortex, but its S/I ratio is on the lower end of the adult australopith spectrum. Overall, the Malapa sample groups roughly with the australopiths and the Dinaledi sample groups with modern humans.

### Estimating Ancestry in Undocumented Migrants along the South Texas Border using Dental Morphological Traits: A Test of Edgar's Method

CHAUNESSEY M.J. CLEMMONS, M. KATE SPRADLEY and DANIEL J. WESCOTT

Anthropology, Texas State University

Dental morphological traits can be used to estimate ancestry, an important factor of the biological profile. Dental traits have been used primarily as a qualitative method until recently. In 2013, Edgar provided a quantitative method for estimating ancestry using dental morphological traits. The logistic regression equations presented in Edgar's method are able to identify and classify unknown individuals into African American (AA), European (EU) and Hispanic American (HA). Edgar's formulas further separate those identified as Hispanic into two geographic categories. The New Mexico Hispanics (NMH) are individuals who are primarily from Mexico or have established family history in the U.S. The Southern Florida Hispanics (SFH) are individuals from the

Caribbean, Cuba and Puerto Rico. In this study 10 (9 male, 1 female) individuals discovered along the southern Texas border and perceived to be Hispanic based on anthropological analyses and cultural profile were scored for thirteen dental traits. Dental traits were observed and scored on both antimeres, when present, of permanent teeth using the Arizona State University Dental Anthropology System and the expression count method. The results show that two individuals classified as HA, two as AA, and seven as EU. Of the two HA individuals only one exhibited enough observable traits to further specify a geographic region, SFH. This preliminary study suggests that Edgar's method is not adequate for estimating group affiliation in undocumented border crossers found along the Texas border.

### Altered DNA Methylation of Methylation Complex Genes in Relation to Maternal Stress

CHRISTOPHER J. CLUKAY<sup>1,2</sup>, DAVID A. HUGHES<sup>3</sup>, NICOLE C. RODNEY<sup>1</sup>, DARLENE A. KERTES<sup>2,4</sup> and CONNIE J. MULLIGAN<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Genetics Institute, University of Florida, <sup>3</sup>MRC Integrative Epidemiology Unit, University of Bristol, <sup>4</sup>Department of Psychology, University of Florida

Early life stress has long been known to influence adult health, with epigenetic modifications recently emerging as a possible mediator for this effect. Working with 25 mother-newborn dyads from the Democratic Republic of Congo, we previously found correlations between maternal stress, newborn birthweight, gene-specific methylation in cord blood, and genome-wide mean methylation in maternal blood, i.e. a possible gene-mediated effect in newborns as opposed to a genome-wide effect in mothers.

Here we investigate ten genes in the methylation/demethylation complex in order to better understand our previous correlations. Mean methylation measures were constructed for each gene using principle component analysis and were tested for correlation with interview and survey-based maternal stress measures (chronic stress and war trauma), genetic variants, maternal and cord genome-wide mean methylation (GMM), and birthweight. After cell type correction, we found correlations between war trauma, maternal GMM, maternal methylation at *DNMT1*, *DNMT3A*, *TET3*, and *MBD2*, and birthweight. *DNMT1* produces the primary enzyme that replicates methylation patterns during DNA replication. *DNMT3A* and *TET3* have been implicated in genome-wide hypomethylation in response to glucocorticoid hormones. Thus, altered methylation, and possibly altered expression, of these genes is consistent with their known role in genome-wide methylation and previous relationships to stress. These results are also consistent with our observed correlation

between maternal GMM and stress, in contrast to cord GMM which was not correlated with stress. Our results suggest that altered methylation of the methylation genes may be part of the molecular mechanism underlying the human biological response to stress.

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### Modularity and the evolution of the human canine

ZACHARY COFRAN

Anthropology, Vassar College, Evolutionary Studies Institute, University of the Witwatersrand

Reduction or absence of the canine honing complex is a defining characteristic of hominins. Various theories have been put forward to explain why natural selection acted to remove this complex, but how this evolved is relatively understudied. The concepts of integration and modularity provide a framework for understanding possible developmental mechanisms of hominization of the canine-premolar complex. In terms of tooth development, it has been suggested that the canine came under the morphogenetic influence of the presumptive incisor field. Here I test the hypothesis that human mandibular teeth will have a distinct incisor+canine module, while chimpanzee teeth will instead have a canine+premolar module. Patterns of covariation between mandibular tooth diameters are examined in sex-separated samples of humans and chimpanzees. Modularity is quantified with the Covariance Ratio, and permutation tests are used to statistically assess whether the canine participates in different modules in humans and chimpanzees.

Results offer mixed support for the hypothesized differences in modularity. Consistent with previous studies, all samples evince anterior vs. postcanine modules. Among humans, there is support for separate incisor+canine and premolar modules for males but not for females. Among chimpanzees there is no support for the module hypothesized to characterize humans, as predicted. Also as predicted, the chimpanzee samples support the presence of a canine+premolar module but the human samples do not. While results support the proposed morphogenetic mechanism underlying hominin canine reduction, other possible reasons for the observed patterns of covariation should also be explored.

### Taphonomic characterization of the honey badger, an actualistic first

BRIGETTE F. COHEN<sup>1,2</sup> and JOB M. KIBII<sup>3</sup>

<sup>1</sup>Department of Archaeology, University of Cape Town, <sup>2</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>3</sup>Palaeontology Department, National Museum of Kenya

## ABSTRACTS

Diagnostic bone modification patterns have been utilised to identify potential carnivore accumulators of fossil mammal assemblages. Studies of this nature have recently begun to focus on modification patterns of small carnivores on smaller prey like hares. The honey badger (*Mellivora capensis*) has a long evolutionary history and has been recovered from a number of Plio-Pleistocene hominid cave sites near Johannesburg. The honey badger is a catholic feeder but is known to predate or scavenge smaller prey items like the springhare. Recent work with camera traps has recorded honey badgers making frequent use of caves and they are known to cache excess food and make use of latrine sites. However their potential as accumulating agents in hominid bearing caves has not been previously investigated. Indeed to the best of the author's knowledge there have been no actualistic taphonomic studies of the honey badger published to date. This study investigated the nature of bone modification of domestic rabbit carcasses by captive honey badger. Domestic rabbit carcasses were fed to honey badger, housed at the Johannesburg Zoo. Skeletal elements recovered from the refuse and those retrieved from the scats were cleaned and analysed. Overall, skeletal part representation and bone modification patterns resemble those observed in other small carnivores such as the red fox. However, unique traits in honey badger bone modifications were observed, resulting in a template that can be employed when interpreting taphonomic histories of fossil small mammal assemblages from palaeontological or archaeological sites.

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### Cross-sectional geometry of the mandibular corpus and food mechanical properties in extant primates

SUSAN COINER-COLLIER<sup>1</sup>, ADAM C. PASQUINELLI<sup>1</sup> and MATTHEW J. RAVOSA<sup>1,2,3</sup>

<sup>1</sup>Biological Sciences, University of Notre Dame,

<sup>2</sup>Aerospace and Mechanical Engineering, University of Notre Dame, <sup>3</sup>Anthropology, University of Notre Dame

The mandibular corpus must withstand the bending, shear, and twisting forces generated by feeding. Experimental studies show relationships between dietary consistency and corpus development, such that animals raised on more mechanically challenging diets tend to have more robust mandibles with thicker cortical bone. To examine this potential functional link, we used data on dietary food mechanical properties (FMPs) to evaluate whether primates with tougher or more resistant diets demonstrate

morphological signals in the mandibular corpus related to load resistance.

To test the relationship between cross-sectional corpus geometry and FMPs, we used a sample of 69 adult mandibles from 17 primate species, including both strepsirrhines and haplorhines. Each mandible was imaged using either HRXCT or microCT. Slices were extracted from the corpus at the left mandibular P4, M1, and M2, and analyzed with BoneJ. For each slice, we calculated cross-sectional area (CSA), cortical bone area, maximum and minimum cortical thickness, second moments of area along the major and minor axes, and Bredt's formula.

Statistical analysis was performed using phylogenetic generalized least-squares multiple regressions of FMPs against geometric variables and mandible length (to control for differences in body size). Our results showed few relationships between FMPs and corpus variables. However, median toughness was strongly related to CSA for M1 ( $p < 0.001$ ,  $R^2 = 0.93$ ), M2 ( $p < 0.001$ ,  $R^2 = 0.96$ ), and P4 ( $p < 0.001$ ,  $R^2 = 0.94$ ). This result suggests that relatively larger mandibles may be necessary to withstand the loading regimes associated with tougher diets.

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### New insights on Broad Translucent Annulations

THOMAS COLARD<sup>1</sup>, MICHEL DUBOIS<sup>2</sup>, AMÉLIE DE BROUCKER<sup>3</sup> and BENOIT BERTRAND<sup>1</sup>

<sup>1</sup>EA7367 UTML, Lille University, <sup>2</sup>Laboratoire de Génie Civil et géo-Environnement (LGCgE), Lille University,

<sup>3</sup>School of Dental Surgery, Lille University

Based on optical microscopy observations, acellular cementum is formed of incremental light and dark layers, deposited in a slow, rhythmic and continuous growth throughout life. Acellular cementum thus behaves like a true biological archive which covers almost the entire adult's life span. The size of these growth markers is variable (generally between 2 and 10  $\mu\text{m}$  wide) and is supposedly linked to changes in phospho-calcium metabolism. But some of them are wider and hypomineralized incremental lines called broad translucent annulations (BTA). Several authors have proposed the hypothesis that these particular rings reflect stress, such as pregnancy, systemic disease and bone trauma, occurring during the year of deposit. Despite recent improvements in cementochronology, BTA remain little studied and poorly understood in terms of characterization, biology and physiology.

By means of polarized microscopy and Environmental Scanning Electron Microscopy equipped with micro-analysis, dental cementum was studied in female subjects of known age and

pregnancies. We made spot analyses to precisely define BTA in term of size, morphology and characterization. Major elements content was analyzed with linear scanning among cementum in order to compare the BTA with known pregnancies. Our results allowed us to link the number and the position of BTA in the acellular cementum deposit with the number and the age of pregnancies. We believe that this presentation will impact the anthropology community by demonstrating how a precise knowledge and detection of BTA may improve the field of biological anthropology and paleodemography.

### Three-dimensional Reconstruction of Vascular Pore Networks in the Human Rib from Two-dimensional Serial Sections

MARY E. COLE and SAMUEL D. STOUT

Anthropology, The Ohio State University

Bone modeling and remodeling are activated by the mechanical strain of physical activities, such as locomotion and subsistence practices. Structural remnants of these processes, particularly cross-sectional geometry and collagen fiber orientation, are commonly used to infer these past behavioral patterns. Cellular processes similarly perforate cortical bone tissue with highly interconnected vascular pore networks. Low strain cortical regions are significantly more porous than high strain regions. Two-dimensional studies suggest that vascular pore volume, connectivity, and orientation also vary with mechanical strain, indicating a potential metric of mechanical loading. This study pilots a method for three-dimensional visualization of vascular pore networks in high and low strain cortical regions. Serial cross-sections ( $n = 88$ , thickness = 30  $\mu\text{m}$  each) of a midshaft human rib (33 year old male), originally prepared by Tappen (1977), were microscopically imaged. High strain (compressed pleural cortex) and low strain (tensed cutaneous cortex) regions were delineated by each cross-section's major axis, and checked by circularly polarized light microscopy analysis of collagen fiber orientation. A semi-automated protocol developed for ImageJ isolated vascular pore spaces using the Colony Blob Count Tool. The Register Virtual Stack Slices plugin aligned serial sections based on pore coordinates. Adjacent section pores were interpolated with the 3D Object Counter, reconstructing the midshaft's three-dimensional vascular space. Pore volume, orientation, and network connectivity were reported by the 3D ROI Manager and AnalyzeSkeleton. Three-dimensional imaging technologies are often limited for bone tissue by resolution, size, or cost. Serial sections are an accessible alternative for reconstructing vascular pore networks.

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## Coordinate-system-invariant Assessment of Measurement Error in Landmark Coordinate Data

THEODORE M. COLE III<sup>1</sup>, LIANGYUAN HU<sup>2</sup>, SUBHASH R. LELE<sup>3</sup> and JOAN T. RICHTSMIEIER<sup>4</sup>

<sup>1</sup>Basic Medical Science, University of Missouri-Kansas City, <sup>2</sup>Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, <sup>3</sup>Mathematical and Statistical Sciences, University of Alberta, <sup>4</sup>Anthropology, Pennsylvania State University

Landmark coordinate data are invariably collected with measurement error (ME). We present methods for quantifying ME under two different digitizing protocols: 1) a specimen is repeatedly measured while held stationary in a fixed coordinate system (FCS), as with CT scans; and 2) a specimen is repeatedly measured in a series of different, arbitrary coordinate systems (ACS), where it is moved between trials and repositioned differently each time. Some authors have argued the ACS protocol is more practical under certain circumstances, and Procrustes superimposition is commonly used to quantify ME in these cases.

We first briefly summarize our existing method of estimation under the FCS protocol. Assuming normally-distributed errors, we obtain maximum-likelihood estimates of ME at each landmark. We then introduce a new method of estimation under the ACS protocol, using an *a priori* model that assumes: 1) normally-distributed errors; 2) possibly heterogeneous error across landmarks; and 3) errors that are uncorrelated across landmarks. We obtain method-of-moments estimates of ME at each landmark that are invariant to the nuisance parameters (translation and rotation) introduced in the ACS protocol. We present simulation studies considering scenarios with varying magnitudes and patterns of ME. We first use the FCS method, followed by the ACS method after introducing nuisance parameters to the data. We find our estimates of landmark-specific ME are accurate under both protocols. Applied to the same data, Procrustes estimates are inaccurate. We conclude with suggestions for mitigating ME when the repeated measurement of large samples is impractical.

## Bipedalism evolved from knuckle-walking: Evidence from 3D geometric morphometric analyses of cervical and upper thoracic vertebral shape of *Homo sapiens*, *Pan troglodytes*, and *Pongo pygmaeus*

MARK COLLARD<sup>1,2</sup>, KIMBERLY A. PLOMP<sup>1</sup>, KEITH DOBNEY<sup>3</sup>, UNA S. VIDARSDOTTIR<sup>4</sup> and DARLENE A. WESTON<sup>5</sup>

<sup>1</sup>Archaeology, Simon Fraser University, <sup>2</sup>Archaeology, University of Aberdeen, <sup>3</sup>Archaeology, Classics and Egyptology, University of Liverpool, <sup>4</sup>Biomedical Center, University of Iceland, <sup>5</sup>Anthropology, University of British Columbia

The locomotor behaviour that preceded bipedalism is an important but controversial topic.

The debate focuses on the locomotor behaviour of the last common ancestor (LCA) of hominins and panins. The most widely supported hypothesis contends that the LCA used knuckle-walking while on the ground, and vertical climbing and forelimb suspension while in the trees, like the African apes. The main alternative to this "African ape hypothesis" avers that the LCA used arboreal quadrumanous climbing and hand-assisted bipedalism similar to orangutans. In this study, we sought to shed light on the LCA's locomotor behaviour by comparing the lower two cervical and upper two thoracic vertebrae of *H. sapiens*, *P. troglodytes*, and *P. pygmaeus* using three-dimensional shape analysis techniques. Asymmetry was removed from the data, and then allometry was minimized by regressing the landmark coordinates on log centroid size. The regression residuals were subjected to principal component analysis, and MANOVAs were performed on the PC scores to assess the significance of the differences among taxa. Lastly, between-group Euclidean distances were calculated to investigate inter-taxon shape variation. The analyses revealed that the vertebrae of *H. sapiens* are more similar in terms of shape to those of *P. troglodytes* than to those of *P. pygmaeus*. These findings are consistent with the hypothesis that the locomotor behaviour of the LCA was similar to that of modern African apes. Thus, the present study adds to the growing body of evidence indicating that bipedalism was preceded by a combination of knuckle-walking, vertical climbing and forelimb suspension.

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## Framing Function, Health, and Disability in the Roman Iron Age: Application of the ICF in Two Individuals with Developmental Dysplasia of the Hip

LARISSA COLLIER and LEAH LOWE

Department of Physical Therapy, University of Central Arkansas

Developmental dysplasia of the hip (DDH) is a joint disorder that typically manifests in utero and throughout the first year of life as the hip socket forms. While many cases spontaneously improve or improve with treatment, some go undetected until clinical symptoms, such as joint pain, joint dislocation, and arthritis are present. Using an archaeological skeletal sample of two individuals with unilateral DDH, this case study will demonstrate the feasibility of using the World Health Organization's International Classification of Functioning, Disability and Health (ICF) as a contemporary framework to explore and conceptualize their likely health, function, and disability.

The cases, a young adult female and middle adult male, are from the Roman Iron Age cemetery of Simonsborg on the island of Zealand, Denmark. Using the ICF, we can propose a descriptive profile of the individuals' function and disability which considers the interactions of DDH (the health condition) with the personal and environmental factors likely consistent with the Roman Iron Age. These interactions will be described through 1) anatomical and physiologic analysis of body functions and structures, 2) archaeological context that examines the individuals' ability to engage in daily activities, and 3) quality of life determined by the individuals' potential level of participation in home and community.

The ICF model provides the framework to merge archaeological context with contemporary anatomical and functional knowledge of the human body to help us conceptualize the effect of disability on the daily life and community interactions of these two individuals from the Roman Iron Age.

## Are virtual bones, derived from clinical CT scans, a precise source for a virtual skeletal reference database?

KERRI L. COLMAN<sup>1</sup>, JOHANNES G.G. DOBBE<sup>2</sup>, KYRA E. STULL<sup>3</sup>, JAN M. RUIJTER<sup>1</sup>, ROELOF-JAN OOSTRA<sup>1</sup>, RICK R. VAN RIJN<sup>4</sup>, ALIE E. VAN DER MERWE<sup>1</sup>, HANS H. DE BOER<sup>5</sup> and GEERT J. STREEKSTRA<sup>2,4</sup>

<sup>1</sup>Anatomy, Embryology and Physiology, Academic Medical Centre, University of Amsterdam, <sup>2</sup>Department of Biomedical Engineering and Physics, Academic Medical Centre, University of Amsterdam, <sup>3</sup>Department of Anthropology, University of Nevada, Reno, <sup>4</sup>Department of Radiology, Academic Medical Centre, University of Amsterdam, <sup>5</sup>Department of Pathology, Academic Medical Centre, University of Amsterdam

Many countries lack contemporary skeletal collections that reflect the diversity in the modern population. A possible solution is the development of a virtual skeletal database from computed tomography (CT) images. Postmortem CT scans, generally conducted under ideal conditions, reflect a specific sub-sample. Clinical CT scans provide a possible solution to capturing the full spectrum of variation, albeit being associated with varying imaging conditions. This study investigates the effects of varying imaging conditions on the precision of virtual modelled pelvises.

One adult cadaver was scanned using varying imaging conditions (i.e., scanner type, slice thickness, and exposure level). Segmentation was used to generate virtually modelled pelvises. The precision of the virtual models was calculated by the fraction of polygon mesh points resulting in point-to-point distance errors of 2mm or less. Additionally, areas that had the 5% most- and the 5% least deviation were visualized by color mapping.

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Almost all polygon mesh points (97%) resulted in point-to-point distance errors of 2mm or less. Joint surfaces predominantly presented with variation greater than 2mm and the 5% most deviation. The anterior- and posterior- surface of the iliac fossa, greater sciatic notch and obturator foramen displayed the 5% least deviation.

Segmented bone elements from clinical CT scans are a precise source for creating a virtual skeletal database. Virtual models provide the possibility to automate measurements and perform shape fitting analyses, which may not only reduce user/measurement error, but also provide information on the spectrum of variation for complex populations with high rates of immigration and migration.

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### The Use of Color Cues in Within-group Competition over Food Resources by Tufted Capuchin Monkeys

AGOSTINA COLOSIMO<sup>1</sup> and CLARA J. SCARRY<sup>2,3</sup>

<sup>1</sup>Facultad de Ciencias Agrarias, Universidad Nacional Rosario, <sup>2</sup>Department of Anthropology, Miami University, <sup>3</sup>Department of Anthropology, University of Texas at Austin

Among many primate species, strong dominance relationships allow some individuals to aggressively exclude others from a resource when they are present. Thus to avoid competition, subordinate individual may attempt to arrive early at resources, gaining time to feed prior to the arrival of more dominant individuals. To avoid investing energy in competition over resources that are not currently productive, individuals may use information acquired during previous visits or through signals visible at greater distances to inform their choice of approach behavior. Here we employed an experimental approach with wild tufted capuchin monkeys (*Sapajus nigritus*) at Iguazú National Park, Argentina, to examine whether color indicators of current food availability (orange vs. white feeding canisters) affect individual behavior during approach to provisioning platforms. Although subordinate individuals routinely arrived at the site well ahead of the group, within visual range of the site, behavior differed in response to the color signals that they detected. When orange canisters indicative of a small quantity of banana were present, individuals maintained a rapid approach velocity. In contrast, when the visible signal (white) indicated that no food was present, individuals slowed in their approach and frequently bypassed the site. Similar use of naturally occurring color cues that can be detected at long-distances and inform individuals regarding current resource availability may help to explain the maintenance of the color vision polymorphism within this population.

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### Morphological integration of anatomical, functional, and developmental modules of the postcranium in the Crab-eating Macaque (*Macaca fascicularis*)

MARK A. CONAWAY, LAUREN SCHROEDER and NOREEN VON CRAMON-TAUBADEL

Buffalo Human Evolutionary Morphology Lab, Department of Anthropology, University at Buffalo

Patterns of morphological integration are important for understanding the potential evolvability of different structures in the primate skeleton. Here, using a macaque model, we test the null hypothesis that anatomically, developmentally, and functionally defined postcranial "modules" exhibit statistically stronger patterns of integration compared with random traits taken from across the whole skeleton. Landmarks were collected on 3D scans of the scapula, os coxa, femur, humerus, tibia, and ulna of 40 *Macaca fascicularis*. All possible interlandmark distances were calculated for each bone. A null distribution of integration measures (ICV; Coefficient of Variation of covariance matrix eigenvalues) was calculated by resampling these traits and calculating random covariance matrices 1,000 times. Thereafter, distributions of ICV values were generated for each of the six anatomical modules (individual bones), three developmentally homologous modules (girdles, upper, and lower limbs) and four functional modules (scapula-humerus, humerus-ulna, os coxa-femur, and femur-tibia). Integration values were statistically compared using pairwise Mann-Whitney U tests with Bonferroni correction.

Results show that all individual bones are significantly more integrated than the null, except for the os coxa, which was significantly less integrated. Of the developmental modules, only the upper and lower limbs were significantly more integrated than the null, while three out of the four functional modules were more integrated than the null. Overall, our results provide partial support for the null hypothesis, with the os coxa displaying significantly lower levels of integration than other modules. The results also point to functional factors being important drivers of morphological integration in the macaque skeleton.

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### Does increased contact with an arboreal substrate result in decreased digital grasping pressures?

KIMBERLY A. CONGDON

Basic Sciences, Touro University Nevada

Arboreal primates engage in a range of climbing behaviors, including above-branch quadrupedalism, below-branch suspension and vertical climbing. Maintaining a stable position on arboreal substrates requires supplementing the force of friction that results from interaction of autopod and substrate. One means of supplementing frictional forces is to increase the amount of contact

(measured as surface area) between grasping digits and substrate. Doing so could allow for lower peak pressures against the substrate. I tested the hypothesis that increasing contact of digits against arboreal substrate results in lower peak grasping pressures during arboreal locomotion in 3 species of lemur. Adults (n=4 /species) from *Lemur catta*, *Propithecus coquereli*, and *Varecia variegata* crossed an artificial substrate fitted with a pressure pad during above-branch quadrupedal, below-branch quadrupedal and vertical-branch quadrupedal locomotion. I used least-squares regression to test for inverse correlations between pressures exerted by individual digits and their surface areas of contact. No correlations yielded an r value of more than 0.64 and the majority of slopes demonstrated a direct correlation, not inverse. Many correlations yielded r values below 0.1. Negative allometry suggests greater constraints on contact surface area than digital pressure. These findings fail to support the hypothesis, and suggest that, when composing an arboreal locomotor strategy, increasing contact surface area is employed in-step with increasing digital pressure, rather than as a means to lower necessary digital pressures. This implies that autopods are able to withstand higher pressures than are employed during stereotypical arboreal behaviors before alternate grasping strategies are necessary to prevent failure.

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### A Test of Fazekas and Kósa (1978) Fetal Aging Standards using Ultrasound Data

JENNIFER A. CONLEY<sup>1</sup> and STEPHEN OUSLEY<sup>2</sup>

<sup>1</sup>Applied Forensic Sciences, Mercyhurst, <sup>2</sup>Data Science, Mercyhurst

Accurately aging fetal skeletons is necessary for both forensic anthropologists and bioarchaeologists. In forensic contexts, it is necessary because of feticide laws. The most widely used method to estimate fetal age is Fazekas and Kósa, who based their method on Haase's Rule, a crude fetal age estimate based on fetal length. A potential problem is their source, spontaneously aborted fetuses from Hungary, because of population differences in fetal size and the osteological paradox. The Osteological Paradox highlights the problem of applying assessments of the dead to the living because the dead are dead for a reason. Spontaneously aborted fetuses may not represent normal growth in fetuses that would otherwise survive. The purpose of this study was to test the F&K method using seven published ultrasound data at various ages from surviving fetuses.

Maximum lengths of the six major long bones were used because of their ease of measurement and the great number of studies using them. The F&K data from all six major long bones

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show significant deficits compared to the ultrasound data at 24 to 36 fetal weeks at  $p < 0.02$  after Bonferroni adjustments. We conclude that the F&K method is inappropriate for estimating age in modern, ostensibly healthy fetuses, and the Haase method is inaccurate. In the future, it is imperative that ultrasound data be used to assess fetal age and population specific standards be created.

### Effect of Cusp Number on the Structural Integrity of Early Hominin Teeth

PAUL J. CONSTANTINO<sup>1</sup>, MARK B. BUSH<sup>2</sup>, AMIR BARANI<sup>2</sup> and BRIAN R. LAWN<sup>3</sup>

<sup>1</sup>Biology, Saint Michael's College, <sup>2</sup>School of Mechanical and Chemical Engineering, University of Western Australia, <sup>3</sup>Materials Measurement Laboratory, National Institute of Standards and Technology

Recent work has examined how tooth structural integrity is affected by various traits such as tooth size, enamel thickness, and enamel material properties. However, little has been done to investigate the role of cusp number. While lower molars of *Homo* and *Australopithecus* routinely feature 4 or 5 cusps, those of *Paranthropus* often feature a sixth (tuberculum sextum). Some "gracile" hominins even feature a seventh cusp despite having smaller molars. We investigated the effect these extra cusps may have had on tooth structural integrity by using extended finite-element modeling to examine longitudinal crack propagation in simplified bunodont tooth models varying in cusp number. We find that extra cusps do not compromise tooth integrity when each cusp is loaded simultaneously, as would be the case when feeding on softer foods. However, feeding on harder foods can result in localized contacts on individual cusps that increase the likelihood of tooth failure. This can be mitigated by moving those cusps towards the center of the tooth or by keeping these localized contacts away from the tooth's edges. Increasing cusp height can also increase the critical failure load of teeth, provided the cusp does not become excessively tall relative to tooth width. Given the location and size of the tuberculum sextum, these cusps would have made the tooth more prone to fracture when consuming hard foods. Therefore, we hypothesize they either enhanced the ability of *Paranthropus* to orally manipulate soft (and possibly tough) foods, or they were simply a developmental byproduct with no selective advantage.

This project was supported by the Australian Research Council (DP130101472).

### New specimens of *Stirtonia* from the La Victoria Formation, La Venta, Colombia and the evolution of alouattin dental and mandibular form

SIOBHAN B. COOKE<sup>1,2</sup>, ANDRES FELIPE VANEGAS<sup>3</sup>, ANDRES LINK<sup>4</sup>, BRIAN M. SHEARER<sup>5,6</sup>, LAURA K. STROIK<sup>7</sup> and MELISSA TALLMAN<sup>2,7</sup>

<sup>1</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>2</sup>, New York Consortium in Evolutionary Primatology Morphometrics Group, <sup>3</sup>, Vigías del Patrimonio Paleontológico La Tatacoa, <sup>4</sup>Department of Biology, Universidad de los Andes, <sup>5</sup>Department of Anthropology, The Graduate Center of the City University of New York, <sup>6</sup>, New York Consortium in Evolutionary Primatology, <sup>7</sup>Department of Biomedical Sciences, Grand Valley State University

*Alouatta* is a wide-spread, speciose genus of largely folivorous platyrrhine primates found throughout Central and South America. One of the major questions about the evolution of *Alouatta* pertains to the selective pressures surrounding the development of its folivorous diet and unique mandibular and hyoid morphology. The earliest definitive fossil alouattin is *Stirtonia victoriae*, which was recovered from the La Victoria formation (13.5-12.9 Ma) of the Middle Miocene site of La Venta, Colombia. It is known only from maxillary and cranial fragments.

Here, we describe the first recovered mandibular specimens of *S. victoriae*. Specimen 1 preserves the mandibular symphysis, tooth roots of the anterior dentition, left and right p3-m2, and a partial left mandibular corpus; specimen 2 preserves the mandibular symphysis containing incisor and canine roots, left p2-m1, and right p2-p4. We employ shearing quotient, a measure of a tooth's relative ability to shear a food item, and 3D landmark-based analyses of dental and mandibular shape to analyze morphological adaptations of *S. victoriae*. The combination of this explicitly functional measure with 3D analyses of shape allow for a multi-faceted approach to dietary reconstruction. *Stirtonia* species have dental morphologies comparable with those of *Alouatta* in 3D analyses of shape. However, *S. victoriae* has somewhat less developed lower molar shearing crests than *Alouatta* – possibly indicating less commitment to folivory at this juncture in alouattin evolutionary history. In addition, the *S. victoriae* mandible appears to be shallower than that of modern *Alouatta*, potentially indicating that enlargement of the hyoid had yet to occur.

This work was supported by the National Geographic Society/Waite Grant W387-15 and the GVSU Center for Scholarly and Creative Excellence. NYCEP Morphometrics Group publication.

### Stable isotope analysis of hair from three peoples in modern Ethiopia shows clear differences among isotopic signatures related to subsistence regimes

CATHERINE G. COOPER<sup>1</sup>, KAREN LUPO<sup>2</sup>, ASHENAFI ZENA<sup>4,5</sup> and MICHAEL P. RICHARDS<sup>3</sup>

<sup>1</sup>Anthropology, University of British Columbia, <sup>2</sup>Anthropology, Southern Methodist University, <sup>3</sup>Archaeology, Simon Fraser University, <sup>4</sup>Anthropology, Washington State University, <sup>5</sup>Anthropology, Hawassa University

We measured the stable isotope ratios (C,N,S) of hair collected from living peoples with differing dietary/economic practices (farmers, pastoralists, fishers) in rural Ethiopia to determine if the dietary differences were visible and measurable in their hair isotope values. We found that there were significant differences in the isotopic ratios of all three elements that distinguish these economic practices (carbon:  $\delta^{13}C = 8.523$ ,  $p = .014$ ; nitrogen:  $\delta^{15}N = 35.372$ ,  $p = .000$ ; and sulfur:  $\delta^{34}S = 30.887$ ,  $p = .000$ ). This demonstrates the utility of isotopic methods as an indicator of diet, and shows the diverse dietary adaptations and economies occurring simultaneously in this region of modern Ethiopia.

### VIRT.OS: virtual osteological library for research, education and heritage preservation

HELENE COQUEUGNIOT<sup>1,2,3</sup>, ANTONY COLOMBO<sup>1,3</sup>, BRUNO DUTAILLY<sup>1,4</sup>, JEAN-FRANCOIS BERNARD<sup>4</sup>, PASCAL DESBARATS<sup>5</sup> and OLIVIER DUTOUR<sup>1,2,6</sup>

<sup>1</sup>UMR 5199 PACEA, CNRS, Univeriste de Bordeaux, <sup>2</sup>Biological Anthropology, Ecole Pratique des Hautes Etudes, PSL Research University, <sup>3</sup>Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>4</sup>UMS 3551 Archeovision, Universite Bordeaux Montaigne, <sup>5</sup>UMR 5800 LaBRI, CNRS, Universite de Bordeaux, <sup>6</sup>Anthropology, University of Western Ontario

VIRT.OS project, granted by the Aquitaine Regional Council, is devoted to the creation of a virtual bone library. Digitalized specimens come from different identified skeletal and osteoarchaeological collections in Aquitaine Region, France and Europe. Its aims are to give an easy access to virtual skeletal specimens having a specific scientific or patrimonial interest while ensuring their preservation. It concerns different sciences dealing with osteological studies such as biological anthropology, archaeozoology and paleontology, anatomy and paleopathology. The project is based on the collaboration between 3 research units located in Aquitaine and specialized in human and animal osteology, computer sciences and 3D methods in archaeology. This interdisciplinary approach allows managing all the steps from data acquisition and treatment to 3D reconstruction including their preservation and promotion. Data acquisition was achieved using CT- or  $\mu$ -CT scans (alternatively using laser

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scanning or photogrammetry), treatment was performed using TIVMI® software program.

Database is continuously enriched with human and animal skeletal specimens coming from different European countries. It is stored in a dedicated platform developed in the framework of a digital research national project for Humanities.

The 3D osteological models can be visualized on the website of VIRT.OS and available for research, education, heritage preservation and valorization for all the specialists working on ancient and recent bones.

*Aquitaine Regional Council, France*

### **Cementochronology to the Rescue: Osteobiography of a Middle Woodland Woman with a Combined Skeletal Dysplasia**

AVIVA A. CORMIER<sup>1</sup>, JANE E. BUIKSTRA<sup>2</sup>, STEPHAN NAJI<sup>3</sup> and THOMAS COLARD<sup>4</sup>

<sup>1</sup>Archaeology, Boston University, <sup>2</sup>School of Evolution and Social Change, Arizona State University, <sup>3</sup>Center for International Research in the Humanities and Social Sciences, New York University, <sup>4</sup>Anthropology, Université de Lille

Accurate age-at-death estimates are essential for inferring health, identity, diversity, and demography within archaeological skeletal samples. Unfortunately, the macroscopically visible skeletal structures most informative for estimating age-at-death ranges may be compromised by dysplastic, endocrine, and circulatory disorders. Cementochronology or the "tooth cementum annulations (TCA)" technique provides an alternative approach for evaluating acellular cementum banding without requiring a reference sample or complex statistical calculations. Using cementochronology, we present an age-at-death estimate for a pre-Columbian, adult female (EZ 3-7-1) with a combined skeletal dysplasia, achondroplasia and Leri-Weill dyschondrosteosis. In 1980, EZ 3-7-1 was excavated from Mound 3 at the Elizabeth site (11PK512) in the Lower Illinois Valley by the Center for American Archeology Contract Archeology Program and the Northwestern University Archeological Field Schools. Preliminary age-at-death estimates were tentative. The presence of *in situ* fetal remains within her pelvis indicates a biologically mature individual, and occlusal dental wear correspond to that of older adults. Cementochronology has re-defined the age-at-death estimate as 31.5+ 1.48 years. These results not only assist in developing a more accurate age-at-death estimation and biological profile, but they also facilitate creating nuanced interpretations for a physically challenged, pregnant female in her Middle Woodland social context. Further, this analysis emphasizes the utility of cementochronology in estimating age-at-death of skeletal individuals with pathological conditions that compromise

commonly used macroscopic methods and encourages researchers to consider this technique in paleodemography, paleoepidemiology, and forensic anthropology.

### **Modern human hair, nail and breath isotopic signals and their relevance to diet assessment in the past**

MARIA ANA CORREIA<sup>1</sup>, ROBERT FOLEY<sup>1</sup>, TAMSIN O'CONNELL<sup>1</sup>, FERNANDO RAMÍREZ-ROZZI<sup>2</sup> and MARTA MIRAZÓN LAHR<sup>1</sup>

<sup>1</sup>Department of Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Dynamique de l'Évolution Humaine, Centre National de la Recherche Scientifique

Diet plays a key role in the ecology of a species. Isotopic analyses are often perceived as the only quantitative and objective technique to assess human diet in the past. However, most studies focus on the comparison of archaeological human isotopic data to animal and other human data, while drawing from theories driven from controlled fed animal studies. This study was designed to test the isotopic outcomes of varied diets on different populations and tissues. In this study, we analyzed human hair (n=134), nail (n=80) and breath (n=184) for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  from 5 modern human populations with different diets. We chose to target African populations (4 Kenyan and one from Cameroon) that exhibited a high range of diets (pastoralism, fishing, agriculture). The sampled populations (EIMolo, Turkana, Luhya, Luo and Baka) practice more traditional diets, thus controlling for the more widespread but historically recent Western diet. A diet questionnaire was also applied to these populations (with the exception of the Baka from Cameroon) to relate individual diet to traditionally reported diets. We found that agriculturalists and hunter gatherers differed from pastoralists and fishers, but it was not possible to distinguish between pastoralists and fishers. This latter result might be due to a nitrogen depletion in Kenyan lakes, which makes the inclusion of fish in diet in this area hard to detect. The results emphasise the importance of local factors in isotope values, and the variable sensitivity of isotopes to dietary practices.

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### **A critical review and classification of juvenile age estimation methods**

LOUISE K. CORRON, FRANÇOIS MARCHAL, SILVANA CONDEMI and PASCAL ADALIAN  
UMR 7268 Anthropologie bioculturelle, Droit, Ethique et Santé, Aix-Marseille University - EFS - CNRS

Age is a parameters of the juvenile biological profile that can be estimated from skeletal or

dental elements with sufficient reliability and precision. However, many juvenile age estimation methods currently available to anthropologists do not follow scientifically or biologically valid methodological criteria.

This work presents a critical review of 256 juvenile age estimation methods. The methods were described using a set of 20 criteria: 5 sampling (age, sex, sample size, sample age ratio and sex ratio), 5 statistical (reliability, accuracy, precision, observer errors, validation) and 10 transversal parameters (e.g. geographic origin). Two or more modalities were then attributed to each criterion, based on recommendations presented in referenced publications for the construction of standardized and valid anthropological methods. Based on this standardized methodological norm, the modalities for sampling and statistical criteria convey either validity or invalidity for the criterion in question.

The modalities of the 10 sampling and statistical criteria were used to understand the structure of our corpus, by calculating frequency tables and conducting Multiple Correspondence Analysis (MCA) followed by Hierarchical Clusterisation on Principal Components (HCPC) with the R® software.

Frequency tables quantified and qualified existing methodological biases. MCA followed by HCPC highlighted the modalities needed to construct valid juvenile age estimation methods.

Following these results, an objective classification of the methods was constructed for each element of the skeleton, based on the descriptive criteria and modalities. This classification highlights the methods respecting all 10 valid sampling and statistical modalities and can be used by anthropologists for practical method selection.

*This study was funded by the French Ministry for Higher Education and Research*

### **Hindlimb Bone Strength Ratios reveal Decreased Limb Tapering in Humans vs. Other Great Apes**

MIRANDA N. COSMAN<sup>1</sup>, STEPHEN SCHLECHT<sup>2</sup>, KARL JEPSEN<sup>2</sup>, LAURA MACLATCHY<sup>1</sup> and MAUREEN DEVLIN<sup>1</sup>

<sup>1</sup>Anthropology, University of Michigan, <sup>2</sup>Orthopaedic Surgery, University of Michigan

Limb tapering is hypothesized to reflect an energetic trade-off between weight and bone strength, and is often associated with cursoriality. Cursorial mammals are also characterized by decreased bending strength of the tibia and longer distal elements. Bipedal humans are hypothesized to be adapted for distance running, and may be characterized by hindlimb tapering. Comparatively, the African apes are less reliant

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on distance running, and thus should be less adapted for cursorial behaviour.

We predict that humans will exhibit greater hindlimb tapering from femur to tibia relative to chimpanzees and gorillas. We also predict that in the forelimb, there will be less tapering from humerus to radius in humans compared to African apes. Data was collected from the Hamann-Todd Osteological Collection. Chimpanzee adults (n=50), gorilla adults (n=78), and human adults (n=240) were pQCT scanned at 50% midshaft, and anthropometric measurements were recorded. J was used as a proxy for limb strength/robusticity, and J-values were compared between femur and tibia, and humerus and radius among all three taxa. In the forelimb, the ratio of humeral J to radial J was not significantly different between humans and chimpanzees, but both exhibited less tapering than gorillas. In the hindlimb, although humans did exhibit limb tapering between their femur and tibia, chimpanzees and especially gorillas had significantly greater levels of tapering ( $p < 0.05$ ). While recent decreases in human femoral robusticity may influence these comparisons, the level of variation among the hominoids, and accentuated tapering in gorilla, suggests the relationship between tapering and locomotor signal is complex.

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### Now they're Everywhere: New Fossil Primate Remains from Bukwa, Uganda, Demonstrate that Catarrhine Primates are Ubiquitous at East African Early Miocene Fossil Sites

SUSANNE COTE<sup>1</sup> and LAURA MACLATCHY<sup>2</sup>

<sup>1</sup>Anthropology and Archaeology, University of Calgary, <sup>2</sup>Anthropology, University of Michigan

Most early Miocene fossil localities in East Africa sample abundant remains of catarrhine primates. In contrast, primates are thought to be relatively rare at Bukwa, a ~19-19.5 Ma locality on the slopes of Mount Elgon in eastern Uganda. Only one definitive catarrhine specimen (*Limnopithecus legetet*) has been documented from Bukwa. Limited paleobotanical evidence, combined with the paucity of primates, have led some to conclude that Bukwa represents an early grassland ecosystem that was relatively inhospitable to primates.

We used systematic surface collection in 2015 to increase the sample size of fossil vertebrate remains from the Bukwa II locality. We discovered five isolated catarrhine teeth, representing three different taxa. Catarrhines now make up 4% of the identifiable mammal fossils our team has collected from Bukwa, comparable to proportions from similarly aged localities at Napak,

Uganda and the Legetet Formation, Kenya. Our preliminary paleoenvironmental findings provide no evidence of grassland ecosystems; rather this was a small lake surrounded by forest and/or woodland.

The new data from Bukwa clarifies that catarrhines are present at all reasonably sampled early Miocene sites and therefore were relatively ubiquitous across East Africa. Bukwa did not represent an open ecosystem, but further work is needed to determine the types of forest or woodland habitats present. Based on these new findings, it is apparent that the perceived paucity of primates at Bukwa was due to the small size of the fossil collection from this locality, rather than an anomalously open habitat in the early Miocene.

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### Virtual cranial restoration of Qafzeh 6 by new methodology using photogrammetry

DANY COUTINHO NOGUEIRA<sup>1,2</sup>, BRUNO DUTAILLY<sup>2</sup>, FLORENT COMTE<sup>3</sup>, ANNE-MARIE TILLIER<sup>2</sup> and HELENE COQUEUGNIOT<sup>1,2</sup>

<sup>1</sup>Laboratoire d'Anthropologie biologique Paul Broca, Ecole Pratique des Hautes Etudes - PSL University, <sup>2</sup>UMR 5199 PACEA, CNRS - University of Bordeaux, <sup>3</sup>UMR 5607 Ausonius, CNRS - University Bordeaux Montaigne

Some fossils, crucial for the understanding of human evolution, are too fragmented or distorted to achieve a comprehensive study of their morphological characteristics. Among these fossils, specimens from Qafzeh Cave in Lower Galilee (Israel), dated to 92 +/- 5 ka BP, are of special interest as they are viewed as being essentially early non-African modern human in skeletal anatomy. They represent a key-group in the knowledge of modern human dispersal with regard to their pivotal geographical location.

The adult Qafzeh 6 skull, which is the most complete, is affected by two distortions as shown by its available physical reconstruction. In order to correct the distorted bones and re-integrate these "corrected" data into the Levantine corpus, we planned a virtual cranial restoration on Qafzeh 6.

CT- or  $\mu$ CT-scans are the common method used in data acquisition for 3D restoration. However, due to strict conservation rules, Qafzeh 6 could not be moved outside its preservation room. Therefore, it was scanned on site, using the photogrammetric method. The acquired data present the advantages to provide both 3D meshes and bone texture. As these digital data are limited to surface acquisition, we have had to develop a specific methodology.

The virtual cranial restoration of Qafzeh 6 skull appeared to us being successful, as it allows us

to answer now some issues raised since these fossils discoveries.

Virtual restoration using photogrammetric data is less expensive and less time consuming than classical methods using X-rays. Its use offers promising insights in virtual paleoanthropology.

*This study was supported by the Irene Levi Sala Care Archaeological Foundation*

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### Rodeo Riders Revisited: A second look at Neandertal patterns of trauma

JAMES BAIN and LIBBY W. COWGILL

Department of Anthropology, University of Missouri, Columbia

Neanderthals have an unusual distribution of skeletal trauma, with high levels of head trauma and few pelvis and lower limb injuries. In their now classic paper, Berger and Trinkaus (1995) compared these patterns of trauma to both archaeological populations and modern hospital samples, in order to shed light on the types of activity patterns that may have led to the relatively unique anatomical distribution of Neandertal trauma. We revisit this topic using a dramatically expanded comparative sample from the National Electronic Injury Surveillance System (NEISS), which includes 84 sets of trauma data from different sports and activities (n=61,667). When the pattern of injury in these living samples was compared to that of Neandertals, 70 groups were significantly different from Neandertals. Of the 14 activities not statistically significantly different, it was difficult to hypothesize analogous behaviors in Neanderthals. These include activities such as water tubing ( $p = 0.812$ ), flying disks and boomerang games ( $p = 0.077$ ), and accidents involving a golf cart ( $p = 0.126$ ). It is possible that this method of drawing comparisons between patterns of Pleistocene trauma and those of modern sports samples may be problematic due to issues of survivorship and small fossil sample size. Alternatively, it also remains possible injury distribution data provides insufficient resolution to interpret past behaviors, due to the wide variety of specific activity patterns that can generate a single distribution pattern.

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### Genetic structure of populations of the Aleutian Archipelago based on 750,000 SNPs

MICHAEL H. CRAWFORD, SARAH D. ALDEN, RANDY DAVID and KRISTINE G. BEATY

Laboratory of Biological Anthropology, University of Kansas

Since 1999, we have conducted research on the origins and genetic structure of indigenous populations of the Aleutian Islands based on uniparental markers—mtDNA and NRY. These studies revealed: (1) that Aleut genetic structure was preserved in the maternal genomes with an

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exceptionally high correlation ( $r=0.68$ ,  $p>0.004$ ) between geographic and genetic distances among 11 islands distributed from the Alaska Peninsula to Kamchatka, Siberia. (2) in contrast, no significant correlation was observed between NRY markers and geography. (3) only 15% of Aleut Y chromosomes originated either in Russia, Scandinavia or England.

This is a follow-up study using buccal swabs from 115 volunteer Aleuts, attending a Corporation meeting in Anchorage, Alaska in 2014. An additional 30 blood samples were collected from Aleuts of Bering Island in 2004. DNA was extracted and a total of 750,000 SNPs were analyzed by FTDNA Genomics Center of Houston, Texas. This new Geno 2.0 Chip is a illumina HD select genotyping bead array that includes mtDNA, NRY and autosomal SNPs distributed throughout the genome. These SNPs were pruned by the removal of related individuals through pairwise linkage disequilibrium (LD) in the PLINK program. PCA analyses were plotted using EIGENSOFT package and population structure was analyzed using ADMIXTURE Program. Intra- and inter-population diversity was estimated using Arlequin software ver. 3.5.

The use of 750,000 mutational markers across the entire genome provided greater precision and statistical power when compared to population structure reconstruction using uniparental markers. Comparative data from NGS allowed localization of gene flow from Europe.

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### Late Pleistocene modern human diversity in Central Africa

ISABELLE CREVECOEUR<sup>1</sup>, ALISON BROOKS<sup>2</sup>, ISABELLE RIBOT<sup>3</sup> and PATRICK SEMAL<sup>4</sup>

<sup>1</sup>UMR 5199 PACEA, Université de Bordeaux, CNRS, <sup>2</sup>Department of Anthropology, George Washington University, <sup>3</sup>Département d'Anthropologie, Université de Montréal, <sup>4</sup>Scientific Service of Heritage, Royal Belgian Institute of Natural Sciences (RBINS)

In the last decade, there has been a growing interest in understanding African Late Pleistocene modern human diversification and dispersion. The Ishango collection represents the oldest sample of modern humans in Late Pleistocene Central Africa. Dated to the last glacial maximum, the human remains are associated with an exceptional archaeological context characterizing a hunter-fisher-gatherer community showing complex social and cognitive behaviors. The comparative study of the Ishango human remains offers a unique opportunity to document and discuss past modern human diversity and adaptation at the end of the Pleistocene. Comparisons with large samples of Late Pleistocene and early Holocene modern

human fossils from Africa and Eurasia show that the Ishango human remains exhibit distinctive characteristics and a higher phenotypic diversity in contrast to recent African populations. In some aspects, these remains show more affinities with Middle to early Late Pleistocene fossils worldwide than with extant local African populations. Moreover, cross-sectional geometric properties of the long bones are consistent with archaeological evidence suggesting investment in and use of aquatic resources. Our results on the Ishango human remains provide insights into past African modern human diversity and adaptation that are consistent with genetic theories about the deep sub-structure of Late Pleistocene African populations and their complex evolutionary history of isolation and diversification.

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### Hale and Frail: Skeletal Frailty in Medieval and Postmedieval London

DOUGLAS E. CREWS<sup>1,2</sup> and KATHRYN E. MARKLEIN<sup>1</sup>

<sup>1</sup>Department of Anthropology, The Ohio State University, <sup>2</sup>School of Public Health, The Ohio State University

To broaden bioarchaeological applicability of skeletal frailty indices (SFIs), we compare results including 2 to 11 non-metric biomarkers to our original metric/non-metric 13-biomarker SFI. By applying identical statistical analyses, we determine if non-metric SFIs yield similar results (means, explained variation, and P-values) to previously reported 13-biomarker SFI distributions. Subsequently, a parsimonious 4-biomarker SFI and 11- and 13-biomarker SFIs are applied to two Postmedieval London cemeteries differing in ascribed socioeconomic status (SES) to test results between multi-variable SFIs and compare frailty distributions between SES groups. From the Museum of London WORD database, 2- to 13-biomarker SFIs are tabulated for Medieval monastic and nonmonastic samples. Nonmetric and 4-biomarker SFIs are applied to Postmedieval high (Chelsea Old Church) and low (St. Brides Lower) SES samples. Medieval samples exhibit similar means, explained variation ( $R^2$ ), and associated P-values (ANOVA/ANCOVA) for the 13-biomarker and all nonmetric SFIs composed of six-plus biomarkers. Nevertheless, comparisons by age indicate non-metric SFIs do not capture childhood growth perturbations associated with adult frailty. Among Postmedieval samples of differential socioeconomic status, 4-, 11-, and 13-SFIs do not differ significantly, although they differ significantly by age and sex within each group. These results demonstrate 13-biomarker SFIs provide a comprehensive assessment of frailty. Results using nonmetric SFIs, with six or more biomarkers, are comparable

to the 13-biomarker index while including larger samples. Regarding differential frailty between Postmedieval London groups, reduced SFIs confirm previous reports based on hazard analyses, which showed significantly higher risks of mortality among individuals of low than high socioeconomic status.

### Oral health among the Hadza foragers of Tanzania

ALYSSA N. CRITTENDEN<sup>1</sup>, SHENIZ MOONIE<sup>2</sup>, JOHN SORRENTINO<sup>3</sup> and PETER S. UNGAR<sup>4</sup>

<sup>1</sup>Anthropology, University of Nevada, Las Vegas, <sup>2</sup>Epidemiology and Biostatistics, University of Nevada, Las Vegas, <sup>3</sup>Family and Cosmetic Dentistry, Private Practice, Hopewell Junction, New York, <sup>4</sup>Anthropology, University of Arkansas

It has long been argued that the transition from foraging to farming was accompanied by an increase in dental caries, orthodontic disorders, and periodontal disease – given the increased consumption of carbohydrates. This commonly cited example of the mismatch between our biology and modern lifestyle is based largely on the bioarchaeological record of the Neolithic Revolution in the New World. Recent studies of other populations have, however, challenged the universality of this assertion. Here, we present the first comprehensive study, to our knowledge, of oral health among the Hadza of Tanzania ( $n = 75$  adult individuals from five camps), a population in transition from hunting-and-gathering to a diet dominated by domesticated foods. In order to test the hypothesis that the shift from foraging to farming inevitably leads to increased periodontal disease, caries, and malocclusion, we compared bush dwelling Hadza to those who have transitioned, or are in the process of transitioning, to the village. Our results suggest that while women in village settings have significantly more caries than those in the bush ( $p<.05$ ), as expected based on data from other small-scale societies, surprisingly, men in the bush have significantly more caries than those in the village ( $p<.05$ ). These unexpected findings might be linked to heavy consumption of honey and, perhaps, the use of tobacco and marijuana. These data support the notions that mechanisms of cariogenesis are multifactorial and that the assumed decline in oral health with the transition to agriculture is nuanced.

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### Comparative foraging strategies of Neotropical frugivores: Do primates forage 'smarter'?

MARGARET C. CROFOOT<sup>1,2,3</sup>, RAFAEL MAREST<sup>2</sup>, DAMIEN CAILLAUD<sup>1,3</sup>, ROLAND KAYS<sup>2,4</sup> and BEN HIRSCH<sup>5</sup>

<sup>1</sup>Anthropology, University of California, Davis, <sup>2</sup>Smithsonian Tropical Research Institute, <sup>3</sup>Animal Behavior Graduate Group, University of California, Davis, <sup>4</sup>Forestry and Environmental Resources, North Carolina State University, <sup>5</sup>Tropical Biology, James Cook University

Making a living as a tropical frugivore poses significant challenges: a medium-sized frugivore's range can contain as many as 100,000 trees, few of which contain food at any given time. In complex environments such as these, the ability to integrate information about what resources are available, where they are located, and when they are ripe dramatically improves foraging success. It has recently been argued that primates, because of their long coevolutionary history with angiosperms, possess cognitive adaptations for foraging on fruit that allow them to forage more efficiently than other frugivores. To test this hypothesis, we used GPS-collars to track the foraging patterns of four frugivores—capuchins (*Cebus capucinus*), spider monkeys (*Ateles geoffroyi*), coatis (*Nasua narica*) and kinkajous (*Potos flavus*)—living in Panama. During the season of low fruit availability, these frugivores are united by an almost exclusive reliance on a single keystone species, *Dipteryx oleifera*, creating a common yardstick to compare their foraging strategies. We exhaustively mapped the distribution of *D. oleifera* trees using drones, and determined which trees study animals visited via GPS tracking. Patterns of movement and foraging behavior differed significantly among study species, with spider monkeys showing strong evidence of route-based travel; their paths also became more directed (i.e. less tortuous) across repeated visits to the same trees. Capuchins foraged more efficiently than other species, encountering more *D. oleifera* per distance travelled. These results suggest that sympatric frugivores may incorporate different types of information into their foraging decisions, even when faced with identical ecological problems.

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### Differences between the endosteal surface of human and non-human long bones: a potential feature to assist with identification

SARAH L. CROKER

Discipline of Anatomy & Histology, School of Medical Sciences, Bosch Institute, University of Sydney

A forensic anthropologist examining skeletal remains must determine if the remains are

human or non-human, but this can be difficult for fragments of long bones, which typically lack diagnostic features. Differences in the presence of trabeculae within the shaft's endosteal region have been noticed between human and non-human long bones. This pilot study employed computed tomography (CT) to clarify such potential differences, using major long bones from four adult human skeletons. The comparative sample used one specimen each from several non-human mammals commonly confused with human remains in Australia, including kangaroos. Firstly, CTs were analysed in transverse view to determine where in the bone shaft trabecular bone was present (completely or partially) or absent. Almost the entire shaft of the human femora and tibiae contained some trabecular bone, as did pig and dog, but at least 26% of the shaft had no trabeculae in the sheep, deer, wallaby and kangaroo. Human upper limb bones, however, lacked trabeculae in up to 30.9% of the shaft's length - more similar to most of the non-human sample. Secondly, the smoothness of the endosteal surface itself was analysed by examining transverse slices at regular intervals along the shaft, and counting the number of longitudinal ridges visible in each. Human bones clearly had more ridges than non-human bones (except cattle upper limb); sheep and deer were almost completely smooth. This study is worth expanding, as a combination of these observations could potentially allow the endosteal surface to provide useful clues when identifying long bone fragments.

### Male Reproductive Strategies in the Context of Female Defense Polygyny: An Agent-Based Model

KRISTIN N. CROUSE and CARRIE M. MILLER

Department of Anthropology, University of Minnesota

Males engage in a variety of mating strategies to be reproductively successful. In primate societies exhibiting female defense polygyny, like gelada monkeys, hamadryas baboons, and some others, a "leader" male assumes dominance over a group of females (one-male unit: OMU) in order to monopolize mating opportunities. While the leader male is assumed a high degree of paternity certainty, the presence of other males may compromise his reproductive success: "follower" males associate with and protect a single OMU and "bachelor" males do not associate with any particular OMU but frequently occupy nearby areas. Here, we present an agent-based model of these three male reproductive strategies (leader, follower, and bachelor) in the context of female defense polygyny. This model investigates how OMU size and composition can affect the opportunities leader, follower and bachelor males have to sire offspring. For example, the number of females per OMU is significantly correlated with leader male ( $r=-0.718$ ,  $p<0.0001$ ), and bachelor

male ( $r=+0.660$ ,  $p<0.0001$ ), but not follower male ( $r=-0.251$ , not significant) reproductive success. Additionally, the number of follower males per OMU is significantly correlated with leader male ( $r=-0.897$ ,  $p<0.0001$ ), follower male ( $r=+0.951$ ,  $p<0.0001$ ) and bachelor male ( $r=-0.959$ ,  $p<0.0001$ ) reproductive success. These preliminary results suggest that (i) leader males do best with small monopolizable OMUs (ii) bachelor males do best when large OMUs do not contain enough follower males to offer sufficient protection, and (iii) follower males employ a "hedge-your-bets" strategy, performing well regardless of OMU size and composition.

### Stress in Transylvania: Utilizing macroscopic skeletal analysis to track metabolic and nutritional stress between Late Antiquity and Middle Ages in Romania

KAYLA D. CROWDER and CHARLOTTE A. ROBERTS  
Department of Archaeology, Durham University

Socio-economic standing, migratory status, and access to adequate nutrition are all crucial when attempting to discover how a population lived and died. Transylvania has experienced periods of unrest for centuries, from the Roman invasion (101 AD), through barbarian raids, migration of the Slavs, to the expansion of the Kingdom of Hungary (1000 AD). As a result of the region's instability due to warfare and invasions, which would impact on the production and availability of food, it is hypothesised that the remains of people excavated from this region will have skeletal evidence of metabolic and/or nutritional stress. The Iclod Necropolis, located in Cluj County, Transylvania, has been associated with Late Antiquity and burials of its inhabitants with the Kingdom of the Gepids. The Bögöz and Fenyéd cemeteries in Odorhei County, Transylvania, have been radiocarbon dated to the 11<sup>th</sup>-12<sup>th</sup> Century AD and the people buried there are thought to represent part of the first migration of Arpadian Age settlers in this region. Macroscopic skeletal analyses were performed on the two skeletal assemblages to assess the prevalence of metabolic/nutritional stress (enamel hypoplasia, porotic hyperostosis, cribra orbitalia, scurvy, etc.).

The resulting data support the hypothesis proposed, with more than fifty percent of the individuals, from each time period, displaying one or more skeletal lesions associated with metabolic and/or nutritional stress. Future research will employ isotopic analyses to explore differences in breastfeeding and weaning practices, overall diet, and migration patterns to better understand how stress affected the life and death of these inhabitants of Transylvania.

*We are grateful to Institute of Medieval and Early Modern Studies, the Rosemary Cramp Fund, and University College, all at Durham University for helping to fund this research.*

## ABSTRACTS

### A multi-isotope investigation of extinct monkey lemurs (*Archaeolemur*) from Antsirondoha cave, Madagascar

BROOKE E. CROWLEY

Anthropology and Geology, University of Cincinnati

*Archaeolemur* spp. may have had slower dental development and larger home ranges than other extinct or extant lemurs. These characteristics make this extinct genus well-suited for investigating shifts in diet and mobility following weaning and potential emigration from natal groups. I sampled enamel from mandibular M1, M3, and P2 for ten *Archaeolemur* from Antsirondoha, which is a limestone cave in northern Madagascar. I analyzed carbon ( $\delta^{13}\text{C}$ ), oxygen ( $\delta^{18}\text{O}$ ), and strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) isotopes, which should reflect the diet, habitat and geology where individuals lived at the time of tooth mineralization. With two exceptions, intra-individual variability in  $\delta^{18}\text{O}$  values is  $<1\%$ . One lemur has elevated oxygen values, suggesting it lived during a slightly drier period than other individuals. Intra-individual variability in  $\delta^{13}\text{C}$  values is  $\leq 2\%$ . All individuals have  $\delta^{13}\text{C}$  values ( $-11$  to  $-15\%$ ) indicative of an arid ecosystem dominated by  $\text{C}_3$  plants (similar to modern conditions). There are no systematic isotopic differences among teeth, suggesting that (1) all teeth mineralized prior to weaning, (2) *Archaeolemur* milk and adult diet did not differ isotopically, or (3) individuals consumed isotopically variable diets before and after weaning. Nine individuals have  $^{87}\text{Sr}/^{86}\text{Sr}$  between 0.704 and 0.705, and intra-individual variability is negligible, suggesting they were relatively stationary. These ratios are lower than expected for limestone but align with estimates for basalts that locally outcrop in valley floors.  $^{87}\text{Sr}/^{86}\text{Sr}$  for one individual is 0.711-0.713, which suggests this lemur was relatively mobile and likely lived on older rocks or alluvium  $>20$  km south of Antsirondoha when it was young.

### A new perspective on the population history of the pre-Incan South Central Andes through analysis of dental morphological data

ANDREA CUCINA<sup>1</sup>, ALFREDO COPPA<sup>2</sup>, CLAUDIA ARGANINI<sup>3</sup> and FRANCESCA CANDILIO<sup>4,5</sup>

<sup>1</sup>Facultad de Ciencias Antropológicas, Universidad Autónoma de Yucatán, <sup>2</sup>Department of Environmental Biology, "Sapienza" University of Rome, Italy, <sup>3</sup>Council for Agricultural Research and Economics, Research Center on Food and Nutrition, Rome, Italy, <sup>4</sup>School of Archaeology and Earth Institute, University College Dublin, Ireland, <sup>5</sup>Physical Anthropology Section, University of Philadelphia Museum of Archaeology and Anthropology, Philadelphia

The complex population history of the pre-Incan South Central Andes has been investigated by a multitude of archaeological and anthropological analyses that have laid a foundation for

the understanding of population movements in the region. Of particular interest is the role played by the Tiwanaku Empire in the peopling of the Osmore and Azapa Valleys, respectively in southern Peru and northern Chile. In the present paper, we combine the dental morphological data available in the literature for both valleys, with new data from Tiwanaku and from sites in central and southern Peru in order to reach a better understanding of the biocultural dynamics exerted by the local Empires' political expansions. Sixteen sites dated from the Archaic to the Late Intermediate periods were analyzed for 39 dental traits. Statistical analyses revealed a close affinity between Chen Chen, a supposed Tiwanaku outpost in the Middle Osmore Valley, and the Moche, the Wari, as well as the actual Tiwanaku sample. Coastal sites from both Valleys gather together, separating from the Middle Valley cluster, indicating that the dynamics that occurred in the Middle Osmore Valley did not affect the population on the coasts. At the same time, continuity can be highlighted between the Azapa Valley sites, both at coastal and valley level. The results obtained are in contrast with previous hypotheses, and stress the need to re-evaluate the role of the Tiwanaku culture in the peopling of both the Osmore and the Azapa Valleys and its ties to the later coastal Chiribaya culture.

### Hyoid Proportions, Growth, and Spatial Placement in Non-Human Primates

ANDREANA S. CUNNINGHAM<sup>1</sup>, TIMOTHY D. SMITH<sup>2</sup> and VALERIE BURKE DELEON<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>School of Physical Therapy, Slippery Rock University

Vocal tract morphology varies throughout non-human primate taxa, directly impacting sound productions that are unique both to species and to individuals. Previous studies have compared whole vocal apparatuses or hyoids in order to contextualize the vocal tract in relation to body size, or the morphological differences across taxa. However, the comparison of neonatal and adult non-human primate hyoid development and structure is an area that has been largely unaddressed. This study examines hyoid proportions in 16 primate taxa. Whole body CT data for  $>25$  specimens were obtained from our work and supplemented by the KUPRI database. The sample included neonate specimens for a subset of the taxa. Metric data were collected in Amira and included linear measurements of hyoid proportions and distance from the cranial base.

Overall hyoid proportions were determined by the ratio of total hyoid length to total width across greater horns. Results indicated significant phylogenetic effects. Hominoids had significantly wider hyoids, cercopithecines had the narrowest hyoids, and platyrrhines were intermediate. Proportions of the hyoid body showed substantial

variation and nonsignificant differences among the phylogenetic groups. Displacement of the hyoid body from basion, scaled by hyoid size, also showed a significant phylogenetic effect. The relative displacement was lowest in hominoids and greatest in cercopithecines. Hyoid proportions remained fairly consistent through ontogeny. However, the relative displacement of the hyoid body from the cranial base actually decreased through time, which may reflect that differential postnatal growth of the skeletal structures exceeds that of the corresponding soft tissue.

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### Sex Determination Using the Proximal Femur: a method for Portuguese Populations

FRANCISCO CURATE<sup>1,2,3</sup>, CLÁUDIA UMBELINO<sup>1,3</sup>, CATARINA NOGUEIRA<sup>2</sup>, ANDREIA PERINHA<sup>2</sup> and EUGÉNIA CUNHA<sup>2</sup>

<sup>1</sup>Department of Life Sciences - University of Coimbra, Research Centre for Anthropology and Health, <sup>2</sup>Department of Life Sciences - University of Coimbra, Laboratory of Forensic Anthropology, <sup>3</sup>University of Algarve, Interdisciplinary Center for Archaeology and Evolution of Human Behaviour

The evaluation of biological sex establishes a pivotal research requirement in the forensic and bioarchaeological analysis of human remains. The best techniques for sex assessment in unidentified skeletal individuals usually rely on the pelvis, and also the cranium and long bones – notably the femur. This study presents a method for sex estimation using the proximal femur that is best suitable for Portuguese populations – both contemporary and from the past. Different measurements (femoral neck width [FNW], neck height [FNH], neck axis length [FNL], biomechanical neck length [FBNL], morphological neck length [FMNL], vertical diameter of the head [FVDH], transverse diameter of the head [FTDH], sagittal subtrochanteric diameter [FSSD] and transverse subtrochanteric diameter [FTSD]) were obtained in a sample from the Coimbra Identified Skeletal Collection (N=176; 88 females and 88 males). Logistic regression was used to construct univariable and multivariable models able to predict sex in unidentified skeletal remains. All models were evaluated using a 10-fold cross-validation. Sex allocation accuracy ranged from 90.3% (using FNW, FNH, FTDH and FTSD) to 75.0% (using FBNL), with bias ranging from 1.1% to 2.9%, respectively. This report highlights the importance of the proximal femur to assess sex in human remains in different states of completeness and preservation.

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## ABSTRACTS

### Characterizing early Pleistocene paleohabitats in Eastern Europe: Results from four years of research in the Olteț River Valley of Romania

SABRINA C. CURRAN<sup>1</sup>, DAVID L. FOX<sup>2</sup>, NICOLE GARRETT<sup>3</sup>, ALEXANDRU PETCULESCU<sup>4</sup>, CHRIS ROBINSON<sup>5</sup>, MARIUS ROBU<sup>4</sup> and CLAIRE E. TERHUNE<sup>6</sup>

<sup>1</sup>Department of Sociology and Anthropology, Ohio University, <sup>2</sup>Department of Earth Sciences, University of Minnesota, <sup>3</sup>Department of Anthropology, University of Minnesota, <sup>4</sup>"Emil Racovita" Institute of Speleology, Bucharest, Romania, <sup>5</sup>Department of Biological Sciences, Bronx Community College, <sup>6</sup>Department of Anthropology, University of Arkansas

Though *Homo erectus* is known from Dmanisi, Georgia at 1.85 Ma, undisputed evidence of hominins in Europe does not occur until 1.4 Ma in Spain. Given the lack of unequivocal evidence for hominins in Europe between 1.85 and 1.4 Ma, we lack a complete understanding of the context of hominin dispersals into Europe. Current data allow for at least two possibilities: 1) some barrier prohibited dispersal into Europe until ~1.4 Ma, or 2) hominins were present but paleontological investigations have not yet uncovered convincing evidence for this presence. However, little paleontological data for the early Pleistocene of Eastern Europe has previously been available to test these alternative hypotheses. Research conducted by the Olteț River Valley Project in Romania over the last four years can shed light on these hypotheses. Data collected by our team allow for preliminary paleoenvironmental reconstructions in this region at the time when hominins may have first dispersed into Europe. We have reanalyzed over 1700 fossils from excavations conducted in the 1960s. Mesowear and stable isotope analyses on ungulate dentition indicate a predominantly browsing signal. However, ecomorphological analyses have revealed that these ungulates were adapted to open habitats. This mosaic pattern has been noted for other European sites and may indicate a habitat type with no modern equivalent. Coupled with continued analysis of previously excavated materials and recovery of fossils from sites in the Olteț River Valley, these data have the potential to further shed light on paleoenvironmental conditions during this critical time period in hominin evolution.

### Biological Distance between Flexed and Supine Burials at the Ancient Greek city of Himera using Dental Nonmetric Data

JESSICA CZAPLA<sup>1</sup>, BRITNEY KYLE<sup>1</sup>, STEFANO VASSALLO<sup>2</sup>, PIER FRANCESCO FABBRI<sup>3</sup> and LAURIE J. REITSEMA<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of Northern Colorado, <sup>2</sup>Director of Archaeology, Regional Archaeological Superintendence of Palermo, Italy, <sup>3</sup>Department of Cultural Heritage, Università del Salento, <sup>4</sup>Department of Anthropology, University of Georgia

We investigate potential differences in genetic relatedness of flexed and supine burials from Himera, a Greek colony on Sicily (648-409 BCE), using biodistance analysis of nonmetric dental traits to explore whether locals adopted Greek burial styles, Greek and local customs hybridized, and/or each group maintained distinct burial styles. In other contexts, supine burials have been associated with Greeks, and flexed burials have been interpreted as representing indigenous individuals. Thus, we hypothesize that supine burials will be more closely related to Greeks from Euboea (indirect founders of Himera) and flexed burials will be genetically distinct, possibly representing locals.

To test our hypothesis, we recorded presence and absence of 34 dental nonmetric traits using the ASU Dental Anthropology System in 57 individuals from Himera (23 flexed, 34 supine) and 45 from Karystos, Greece. Pseudo-Mahalanobis  $D^2$  matrices using different trait combinations were used to estimate biological distance among groups. These analyses showed that the individuals buried in flexed and supine positions are genetically similar to one another and distinct from Karystos, suggesting that there were no major genetic differences between the burial types at Himera. The only trait that was significantly different between the two burial styles was the interruption groove (i.e., the "Etruscan" lateral incisor), which was significantly more common in the flexed burials (present in 88% of flexed and 59% of supine graves; Fisher's Exact test  $p=0.0496$ ). Genetic similarity of the flexed and supine individuals suggests that despite cultural differences in burial practice, the groups likely interbred.

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### Subfamily Affiliation Conditions Bone Stiffness in Tai Forest Monkeys

DAVID J. DAEGLING<sup>1</sup>, JAMES D. PAMPUSH<sup>2</sup> and W. SCOTT MCGRAW<sup>3</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Evolutionary Anthropology, Duke University, <sup>3</sup>Anthropology, The Ohio State University

Bone material stiffness is variable within and among skeletal elements, as well as among individuals, populations and species. While explanations for such differences are often expressed in biomechanical terms, it is known that genetic background can have a significant impact on bone mechanical properties and functional adaptation.

Microindentation surveys of bone hardness (a proxy for stiffness) from mandibles of monkey populations from Tai Forest, Côte d'Ivoire reveal differences among the colobine and

cercopithecine species sampled. Specifically, the sooty mangabey has relatively stiff mandibular bone, possibly related to its habitual processing of hard nuts. On the other hand, Diana monkeys typically exhibit stiff bone relative to Tai colobines, despite no evidence suggesting these guenons feed on hard or tough items. These observations prompt the question of whether unspecified phylogenetic factors govern bone stiffness in cercopithecoids.

We used generalized linear mixed models in a Bayesian framework to examine mandibular bone stiffness for *Cercocebus atys* (N=9), *Cercopithecus diana* (N=3), *Ptilocolobus badius* (N=4), *Colobus polykomos* (N=4) and *Procolobus verus* (N=4) with phylogeny treated as a random effect. The model indicated a significant effect of subfamily affiliation on bone stiffness, with colobines exhibiting more compliant bone. This difference is observed despite large interspecies differences in ingestion of hard and tough foods within each subfamily. This finding does not necessarily obviate functional explanations, as field observation of these populations suggests that colobine monkeys are engaging in more masticatory cycles per day than their cercopithecine counterparts in the Tai Forest.

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### The accuracy of tibial nutrient foramen vs. midshaft measurement location for sex determination

ASHLEY C. DAFGE<sup>1,2</sup> and DAVID HUNT<sup>1</sup>

<sup>1</sup>Department of Anthropology, National Museum of Natural History, Smithsonian Institution, <sup>2</sup>Department of Anthropology, University of Wyoming

Recently, standard measurements for the Forensic Databank have been changed to measure the diameters of the tibia at the midshaft, rather than at the nutrient foramen. This change may be predicated on intra-person variation in nutrient foramen location and inaccuracy of inter-observer measurement location.

This examination assesses the accuracy of determining sex from the two measuring locations - is there a significant advantage to using measurements collected at the midshaft instead of or in addition to nutrient foramen based measurements?

Tibial measurements of 400 individuals were collected from the Robert Terry Anatomical Skeletal Collection following the standard osteometric protocols. Data were randomly divided into testing and training sets. Discriminant functions were created in "R" statistical package using left side measurements from the training set. The derived discriminant functions were applied to left only and then left and right measurements in the testing set. Maximum length

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and proximal and distal epiphyseal breadth, were included in all analyses.

Results indicate that proximal and distal epiphyseal breadths were consistently good predictors. Maximum medial-lateral measurement from the crest was a better sex predictor (91.5% correct versus 90% correct). Midshaft minimum diameter and circumference measurements were good sex predictors (88% correct). Combined nutrient foramen and midshaft measurements lost no accuracy (89% correct).

The results from this study indicate there is no significant advantage of sex determination based on measurements taken at the nutrient foramen compared to those taken at the midshaft.

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### Preliminary results of a vocal self-recognition test in northern white-cheeked gibbons (*Nomascus leucogenys*)

JUSTIN D'AGOSTINO<sup>1</sup>, CHRISTINA PASETTA<sup>2</sup> and ULRICH REICHARD<sup>1,3</sup>

<sup>1</sup>Anthropology, Southern Illinois University,

<sup>2</sup>Anthropology, San Diego State University, <sup>3</sup>Center for Ecology, Southern Illinois University

Recognizing the self in a mirror is an important ability often linked to self-awareness. Among anthropoids, humans and great apes have demonstrated self-recognition in the mirror self-recognition test (MSR). In contrast, small Asian apes usually fail or show ambiguous results in the MSR task and only few researchers currently maintain that hylobatids have cognitive abilities comparable to those of great apes. We suggest that past self-recognition tests in the visual modality may have been unsuccessful because discriminating the self from others is more relevant in the auditory domain in the highly vocal hylobatids. We devised a novel auditory self-recognition test to shed more light on hylobatids potential self-awareness and cognitive capacities by testing 10 northern white-cheeked gibbons (*Nomascus leucogenys*) at the Gibbon Conservation Center, CA. We hypothesized that if self-awareness existed, individuals would discriminate their own from a neighbors' call. We used the close-range "hoo" call, which was recently shown to be individually discriminable, and predicted individuals would gaze towards the speaker when hearing a playback of their own "hoo" call, but would look towards a neighbor's enclosure upon hearing a neighbor's "hoo" call. We tracked eye gaze using cardinal directions and tested experimental gaze direction against an average gaze direction taken from baseline behavioral data. Subjects significantly changed their gaze direction in the predicted way (one-way Z-tests: cv 1.645; range 0.02-1.845;  $1\pm=0.05$ ). Overall, our findings were consistent with vocal

self-recognition, which suggests that hylobatids may also be self-aware.

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### Coordination of Upper and Lower Primary Postcanine Tooth Size in the Haplorrhine Primates by the Inhibitory Cascade

E. SUSANNE DALY<sup>1,2</sup>, KIERSTIN K. CATLETT<sup>1</sup>, STEPHEN KING<sup>3</sup>, KAREN SAMONDS<sup>4</sup>, LAURIE R. GODFREY<sup>3</sup>, GARY T. SCHWARTZ<sup>1,2</sup> and ALISTAIR EVANS<sup>5</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Institute of Human Origins, Arizona State University, <sup>3</sup>Department of Anthropology, University of Massachusetts Amherst, <sup>4</sup>Department of Biological Sciences, Northern Illinois University, <sup>5</sup>School of Biological Sciences, Monash University

Precise occlusion in the upper and lower teeth of primates likely requires tight developmental control over their size and shape. Here we use the inhibitory cascade, an evolutionary-developmental rule, to investigate the developmental basis of this occlusion. This developmental rule predicts the primary postcanine teeth (the deciduous second, third and fourth premolars, and the first, second, and third molars) will change in size in a linear pattern, such that each tooth should be the average size of the teeth on either side. When the tooth row changes from increasing to decreasing in size, this indicates a reversal in the inhibitory cascade pattern, a pattern previously shown to exist in modern humans and hominins. As a consequence the size of the primary postcanine dentition is integrated along the row. Previous work has demonstrated this pattern in primates in the lower tooth row. We hypothesize that if tooth size in both arcades is controlled by the inhibitory cascade, then changes in relative tooth size in the mandible and maxilla should be synchronized to maintain occlusion during development. To test this hypothesis, we analyzed relative tooth size in 50 extinct and extant primate species. We demonstrate a synchronization of the inhibitory cascade pattern in the upper and lower jaws, i.e., they possess similar slopes and reversal points. These results show that in most primates the inhibitory cascade has largely controlled the integration and precise occlusion of the mandibular and maxillary primary postcanine dentition.

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### Cultivating collaboration through student-centered independent study

JENNIFER DANZY CRAMER

Sociology & Anthropology, American Public University System

Student-centered learning opportunities build skills and confidence by bridging traditional classroom instruction with experiential, applied learning. For physical anthropologists at teaching institutions, there are ample opportunities to

fuse research and teaching by creating formal or informal independent study opportunities for students. Traditionally, faculty may work with students to flesh out their interests in the field by creating an independent study course where students focus on a particular topic, reading seminal and recent research. AACT members have discussed a creative alternative, sharing small datasets from incomplete projects with advanced level students. This gives students the opportunity to practice their research skills from literature review to data analysis to presentation or publication. Beyond the classroom, final products can be tailored to contribute to the student's development and larger goals. Students may need a writing sample for graduate school, a project management sample for employment, or a first entry on their resume or curriculum vitae. In this presentation I will use two case studies to highlight ways to: 1) identify students who are likely to benefit from and be successful with an independent project; 2) sharpen and enhance methods and analysis skills previously learned in the classroom; and 3) collaborate effectively with students. Whether students intend to continue in physical anthropology or not, independent study projects can cultivate highly transferrable interpersonal, cultural, and research skills that fit with other career goals students are pursuing.

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### The Middle Pleistocene Human Cranium from Gruta da Aroeira Acheulian site Aroeira (Almonda Karst System, Torres Novas, Portugal)

JOAN DAURA<sup>1</sup>, MONTSERRAT SANZ<sup>2</sup>, JUAN LUIS ARSUAGA<sup>3</sup>, ROLF QUAM<sup>3</sup>, DIRK L. HOFFMANN<sup>4</sup>, MARIA CRUZ ORTEGA<sup>2</sup>, ELENA SANTOS<sup>2</sup>, SANDRA GÓMEZ<sup>5</sup>, ANGEL RUBIO<sup>6</sup>, LUCIA VILLAESCUSA<sup>5</sup>, PEDRO SOUTO<sup>7</sup>, FILIPA RODRIGUES<sup>7</sup>, JOÃO MAURICIO<sup>7</sup>, ARTUR FERREIRA<sup>7</sup>, PAULO GODINHO<sup>7</sup>, ERIK TRINKAUS<sup>8</sup> and JOÃO ZILHÃO<sup>9</sup>

<sup>1</sup>UNIARQ-Centro de Arqueologia, University of Lisbon, <sup>2</sup>Centro UCM-ISCIII de Investigación sobre la Evolución y Comportamiento Humanos, Universidad Complutense de Madrid, <sup>3</sup>Department of Anthropology, Binghamton University, <sup>4</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>5</sup>Grup de Recerca del Quaternari, University of Barcelona, <sup>6</sup>Laboratorio de Antropología, Depto de Medicina Legal, Toxicología y Antropología Física, Universidad de Granada, <sup>7</sup>Crivaraque, Crivaraque, <sup>8</sup>Department of Anthropology, Washington University, <sup>9</sup>ICREA (Catalan Institution for Research and Advanced Studies), University of Barcelona

Human variability in the earlier Middle Pleistocene of Europe is poorly known, which makes it difficult to assess patterns of human diversity and possible regions for ancestral populations associated with the western Eurasian spread of the Acheulian technocomplex. A recently discovered partial cranium from the Gruta da Aroeira may shed some light on this period. U-series dating provides an age  $\approx 400$  ka, placing the fossil in

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the relevant time period. This cave site was first excavated between 1998 and 2002, revealing a rich collection of Acheulian bifaces in association with large mammals and two human teeth. Work resumed in 2013, intent on reaching bedrock and establishing the chronology of the sequence, which spans 4 m and comprises three major stratigraphic units. A partial human cranium encased in rock-grade breccia was discovered at Unit 2. It consists of a large part of the right side of a braincase, lacking the occipital bone, but also preserving a portion of the left side of the frontal squama and supraorbital torus, as well as the interorbital region, including the vertical part of the nasal bones. A fragment of the right maxilla, with two molars partially preserved, was also found attached to the calvarium but not in anatomical position. Some Aroeira features are primitive traits found on some Middle Pleistocene fossils from the Sima de los Huesos, Caune de l'Arago and Ceprano, but not found in Neandertals and are consistent with a geological age between 400 ka and 500 ka.

### The role of host genetics in determining human gut microbiome composition

EMILY R. DAVENPORT

Department of Molecular Biology and Genetics, Cornell University

The billions of single-celled organisms that colonize the human body are increasingly recognized as playing important roles in host physiology and disease. Characterizing what factors determine the composition of these cells, or the microbiota, is therefore of great importance to understanding human health and evolution. While environmental factors have been studied extensively, such as diet, use of antibiotics, and microbial exposure at birth, relatively little is known about the role that host genetics plays in determining human gut microbiome composition. To address this gap, I examined the role of host genetics in determining the gut microbiome in multiple populations of European descent. First, I examined the fecal microbiomes of Hutterite individuals using 16S rRNA gene sequencing. The Hutterites are an isolated, founder population in the United States who live and eat communally, which reduces the inter-individual variability in diet compared to many populations in the United States. Genome-wide association studies (GWAS) performed in ~130 individuals revealed genome-wide significant associations of the abundances of individual bacterial taxa found in feces to host genetic variation. Second, the fecal microbiomes of >2,000 individuals from the United Kingdom Adult Twin Registry (TwinsUK) were characterized. Results highlight regulation of gene expression in the colon as a mechanism for how host genetic variation may influence microbial abundance in the gut. Finally, both studies revealed associations between host genetic variation near the lactase

gene and the abundance of *Bifidobacterium* in feces. These studies demonstrate that human genetic variation plays a role in determining microbiome composition.

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### Pellagra mortality in the historic Mississippi State Asylum: An investigation and comparison of skeletal data and institutional records

MICHELLE L. DAVENPORT<sup>1</sup>, MOLLY K. ZUCKERMAN<sup>1</sup>, NICHOLAS P. HERRMANN<sup>2</sup> and MICHAEL MURPHY<sup>3</sup>

<sup>1</sup>Department of Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>2</sup>Department of Anthropology, Texas State University, <sup>3</sup>Department of History, Mississippi State University

Pellagra has no known pathognomonic skeletal characteristics, but impacted historic agricultural populations and may have affected prehistoric agricultural Amerindian populations. We compare a skeletal sample (N=19) from the historic Mississippi State Asylum with patient records (N=3445) to determine if a proposed combination of skeletal markers, alveolar bone loss and reduced bone remodeling, are associated with pellagra mortality. Chi-square tests of pellagra mortality in the records indicate its association with age ( $X^2=114.61$ ;  $p<0.001$ ) and sex ( $X^2=112.63$ ;  $p<0.001$ ). Logistic regression will identify interactions between age, sex, and pellagra mortality. If co-occurring skeletal markers indicate pellagra, co-occurrence should be similar to pellagra mortality for the overall sample as well as for age and sex. We hypothesize that rates of co-occurring skeletal markers are statistically similar to rates of pellagra mortality overall, for sex, and for age. Individual biological profiles were created, alveolar bone loss was coded, and histological analysis identified reduced bone remodeling. Fisher's Exact tests compared skeletal data to pellagra mortality. Results indicate that pellagra mortality is similar to the co-occurring skeletal markers overall ( $p=0.788$ ) and for age ( $p=0.261$ ), but is significantly *different* for sex ( $p=0.005$ ). Our hypothesis is only partially supported: the rate of co-occurring markers does not fit pellagra mortality rates for sex demographics. Results suggest a need for further work to determine the skeletal markers' association with pellagra. Given the potential public health importance of pellagra for agricultural and refugee communities, future studies should focus on analyzing these markers in larger samples with documented high rates of pellagra.

### Collective-Decision Making and Social Foraging Behavior in White-Faced Capuchins (*Cebus capucinus*)

GRACE H. DAVIS<sup>1,2</sup> and MARGARET C. CROFOOT<sup>1,2</sup>

<sup>1</sup>Anthropology, University of California, Davis,

<sup>2</sup>Ecology, Smithsonian Tropical Research Institute

To obtain the benefits of sociality, animal groups must remain cohesive, reaching consensus and coordinating activities. However, optimal foraging strategies of individual group members often vary, creating conflicts of interest about foraging choices. When conflicts of interest about when and where to feed exist in a group, some individuals must compromise their preferred behavior, presumably at a cost to themselves. This study applies decision-making theory by extending Charnov's marginal value theorem model to group foragers. Specifically, we test the hypothesis that social dominance, size, and age impact how long individuals prefer to remain in a foraging tree, creating conflicts of interest over patch departure time. Using a 3-month study of 2 groups of white-faced capuchins (*Cebus capucinus*) at Barro Colorado Island, Panama, this study examines individual differences in optimal patch departure time and how these translate into collective decisions. Using the focal tree method on group feedings on *Attalea butyracea* palm infructescences, we calculated exact individual feeding rates over time for all group members in each palm (88 total trees). These feeding rates generate individual foraging gain curves that predict optimal patch departure times. Preliminary results indicate inter-individual differences in optimal patch departure time exist and suggest that group decisions are shared between adult individuals. Together, this captures important elements of group decision-making in social primates: where to move, when to go, and who decides.

G. H. Davis was funded by a Smithsonian Tropical Research Institute short-term fellowship while conducting this research in Panama.

### Evidence for specialized processing of facial kinship cues

LISA M. DEBRUINE, EILIDH TURNER, ROSIE GORDON and BENEDICT C. JONES

Institute of Neuroscience and Psychology, University of Glasgow

Many aspects of human face processing, such as identity, gender and normality judgments, are severely disrupted by inversion. This inversion effect is thought to be a hallmark of configural processing, while featural processing is unimpaired by inversion. Here, we present three tests of the hypothesis that allocentric kin detection does not rely on configural information. First, we found that kinship detection was not decreased by face inversion when face pairs were simultaneously presented for an unlimited duration. Second, we

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replicated this finding in a new paradigm where face pairs were sequentially presented for a brief duration. Third, we found that computer-graphic manipulation of configural information in face images did not influence kinship detection. These studies suggest that kin recognition from facial appearance is not simply a byproduct of face perception abilities such as identity recognition.

*This work is funded by ERC Consolidator grant 'KINSHIP'.*

### Megalencephaly and Macrocephaly Genes are Associated with Comparative Variation in Primate Brain Size

ALEX R. DECASIEN<sup>1</sup> and AN-DI YIM<sup>2</sup>

<sup>1</sup>Anthropology, New York University, <sup>2</sup>Anthropology, University of Illinois at Urbana-Champaign

Understanding the evolution of the primate brain requires an understanding of the genetic mechanisms underlying comparative variation in brain size. Recent studies suggest genes linked to human microcephaly have been subject to positive selection across the primate phylogeny, are associated with brain mass increases across species, and even contribute to brain size sexual dimorphism. Here, we examined the evolutionary histories of genes associated with human megalencephaly (abnormally large, malfunctioning brain) and/or macrocephaly (abnormally large skull, not necessarily malfunctioning brain) and their relationship to brain size evolution across 12 primate species. We used phylogenetic generalized least squares regression (PGLS) to test for positive relationships between selection pressure (root-to-tip  $dN/dS$ ) and both brain size and sexual dimorphism for each gene. We also performed multiple regressions to examine these relationships with  $dN$  and  $dS$  as independent variables. Three of the genes examined (*PIK3CA*, *BRWD3*, *AKT1*), which are involved in cell proliferation and apoptosis, exhibited positive associations with brain size. We detected a positive association between  $dN$  and brain size for *BRWD3* and *AKT1*, and negative relationships between  $dS$  and brain size for all three genes. This suggests that the association between  $dN/dS$  and brain size for *BRWD3* and *AKT1* may be driven by an accelerated  $dN$ , while the association for *PIK3CA* may be more complex. In addition, *PIK3CA* and *BRWD3* show  $dN$ -driven positive associations with sexual dimorphism, a result supported by sex-biased expression of these genes during the fetal period. These results support a partially conserved genetic basis underlying primate brain size evolution.

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### Maternal and paternal anthropometry influences on body size, body shape and obstetric capacity in growing girls

SARAH-LOUISE DECRAUSAZ<sup>1</sup>, JAY T. STOCK<sup>1</sup>, MARY S. FEWTRELL<sup>2</sup>, JANE E. WILLIAMS<sup>2</sup> and JONATHAN CK. WELLS<sup>2</sup>

<sup>1</sup>Division of Biological Anthropology, Department of Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Childhood Nutrition Research Centre, University College London Institute of Child Health

Body size and shape is influenced by genetic and environmental factors. Studies have demonstrated that parental body mass index (BMI) affects offspring body composition, particularly maternal BMI. It has also been demonstrated that maternal BMI is associated with neonatal adiposity and birthweight, whilst paternal body size is associated with limb lengths. However, patterns of phenotypic inheritance for body shape, particularly body breadth, are not clearly understood. Maternal stature associates significantly with bony pelvic inlet and outlet in women and in clinical contexts short maternal stature is used as a risk factor for obstructed labour. Examining the relationship between parental BMI, and filial body breadth may illuminate patterns in development of obstetric capacity throughout female puberty. In this study, the BMI, hip and waist circumference of 250 girls from London, UK between the ages of 4 and 21 were tested for a relationship with their maternal and paternal BMI. A growth chart identifying hip and waist variation with BMI was produced of 53 of the 250 girls that were re-measured every 2 years. Variables were converted to z-scores to enable accurate body composition comparison between adults and growing children. Multiple regression analyses demonstrate that there is a correlation between maternal BMI and filial BMI. There is a significant association between maternal and paternal BMI and filial waist and hip circumference. Results show both maternal and paternal influence on body breadth in growing girls, suggesting that future investigations of obstetric capacity in adult women should not exclude paternal body composition.

### Engendering Identity to Anatomical Collections: Using History, Embodiment Theory, and Ethics to Humanize Skeletons

CARLINA M. DE LA COVA

Anthropology, University of South Carolina

Ethical practices should comprise bioanthropological and bioarchaeological training, regardless of whether or not scholars are working with indigenous individuals, both living and deceased. Anatomical collections should not be exempt from ethically conscious research. This is especially true in the United States, where many biological anthropologists have worked with the Hamann-Todd and Terry anatomical collections. Although these subjects were legally

obtained, contemporary anatomical legislation targeted poor and marginalized individuals, so their bodies could be used for medical education without consent before the willed body acts in the mid-20th century. This poster will discuss how to perform ethically conscious research with anatomical collections by humanizing the individuals within these samples. It acknowledges their origins, including the role that racism and societal discrimination played in their inclusion in these collections. Also considered are theoretical approaches that illustrate how the persons that comprise Hamann-Todd and Terry embody the social experiences of their lifetimes and symbolically embody their status of the dissected destitute in death.

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### Spandrels and Functional Matrices: the Ontogenetic Basis for Primate Postorbital Septation

VALERIE BURKE. DELEON<sup>1</sup>, ALFRED L. ROSENBERGER<sup>2</sup> and TIMOTHY D. SMITH<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Florida,

<sup>2</sup>Department of Anthropology and Archaeology, Brooklyn College, <sup>3</sup>School of Physical Therapy, Slippery Rock University

We recently described ontogenetic evidence that postorbital septation in tarsiers occurs secondary to eye hypertrophy. Here we present morphometric evidence on the relationship of postorbital bony structure with multiple functional matrices (eye, brain, dentition) in developing primates.

Our sample included perinatal strepsirrhine and haplorhines. Virtual reconstructions of crania were created from microCT image data, some involving digital transformations to repair bone missing or damaged by necropsy or previous destructive analysis. Landmark coordinate data representing shape and spatial relationships of brain, orbit, dentition, and cranial base were collected in Amira and analyzed using the R Geomorph package.

Major clades of primates had significantly different cranial configurations at birth. Strepsirrhines were characterized by a zygomatic process of the frontal bone that projected lateral to the anterior cranial fossa. Anthropoids were characterized by both lateral expansion of the anterior cranial fossa and inferolateral projection of the middle cranial fossa relative to the facial skeleton. In contrast, tarsiers displayed lateral expansion of the anterior cranial fossa, but not corresponding expansion of the middle fossa. Spatial relationships among soft tissue functional matrices in the developing primate head appear to establish the foundation of bony postorbital anatomy. Postorbital bars and septa may then be co-opted postnatally for specific

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functions (muscle insertions or insulating the eye). An ontogenetic structural model for postorbital septation may be more informative than purely functional models for understanding the evolutionary history of postorbital anatomy in primates. For example, narrow anterior cranial fossae in fossil tarsiforms predicts the presence of a postorbital bar.

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### Metric Variation in *Homo naledi* Molars

LUCAS K. DELEZENE<sup>1,2</sup>, JOEL D. IRISH<sup>2,3</sup>, MATTHEW W. SKINNER<sup>2,4,5</sup>, JULIET BROPHY<sup>2,6</sup>, JOHN HAWKS<sup>2,7</sup> and LEE R. BERGER<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Arkansas, <sup>2</sup>Evolutionary Studies Institute and Centre for Excellence in PaleoSciences, University of the Witwatersrand, <sup>3</sup>Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, <sup>4</sup>School of Anthropology and Conservation, University of Kent, <sup>5</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>6</sup>Department of Geography and Anthropology, Louisiana State University, <sup>7</sup>Department of Anthropology, University of Wisconsin-Madison

*Homo naledi* was diagnosed as a novel hominin taxon based upon the anatomy of undated, commingled fossils from a single chamber in the Rising Star cave system. The initial description highlighted the morphological homogeneity of the sample and suggested that the observed variation is consistent with that found in a single biological population. Here, we provide a metrical assessment of that hypothesis using dental size data. Analyses were performed on buccolingual measures, which are less affected by occlusal and interproximal wear than are mesiodistal dimensions. We focused on the abundantly-represented mandibular and maxillary first and second molars; where antimeres were identified, their values were averaged ( $n = 7 M_1$ s, 6  $M_2$ s, 8  $M^1$ s, and 5  $M^2$ s). Using bootstrapping procedures, we compared *H. naledi* coefficients of variation (CVs) to large samples of southern African humans, San ( $n = 86$ ) and Pedi ( $n = 177$ ), and to geographically restricted samples of *Pan troglodytes troglodytes* ( $n = 115$ ), *Gorilla gorilla gorilla* ( $n = 131$ ), *Hylobates lar carpenteri* ( $n = 87$ ), and *Cercopithecus nictitans nictitans* ( $n = 84$ ). In all cases, the *H. naledi* CVs are low ( $M_1 = 2.81$ ;  $M_2 = 2.89$ ;  $M^1 = 2.81$ ;  $M^2 = 4.0$ ) and in none of the 24 comparisons was variation in *H. naledi* found to exceed that of the reference samples. In fact, the *H. naledi* CVs fell near the lower confidence limits of the resampled distributions for most comparisons. These findings confirm that the known *H. naledi* dental assemblage is remarkably homogeneous in size.

### Running behavior predicts brain size in primates

ALICIA M. DELOUIZE and FREDERICK L. COOLIDGE  
Center for Cognitive Archaeology, Department of Psychology, University of Colorado at Colorado Springs

Research has shown that endurance running leads to neurogenesis, neuroprotection, and improved cognitive capacities. Although most studies have used subjects from a single species, it is possible that running behavior could have affected the brain on an evolutionary time scale. If this proposition is correct, then the average velocity at which a primate moves should be predictive of brain size. Data on 50 non-human primate species was collected from appropriate literature and the average day journey length (m) was divided by the average amount of time spent in locomotion (s) yielding average velocity (m/s). Multiple regression analysis revealed that velocity, group size, and body weight accounted for 94% of the variance in endocranial volume, and velocity was a significant predictor of brain size. Additionally, velocity was a better predictor of brain size than group size. This study may be the first to use a behavioral measure which demonstrates that running is predictive of brain size. Further, this finding may have implications for the encephalization seen during the hominin lineage, which is temporally related to the evolution of the *Homo* skeleton for endurance running.

### Similarities in Pelvic Dimorphism Across Populations

HILLARY DELPRETE

History and Anthropology, Monmouth University

It is well documented that the shape and size of the pelvis of males and females differ, due in part, to the differing constraints of the sexes. Further, changes in nutrition, activity levels, age, and climate also affect pelvic shape and size. With such a myriad of selection pressures, it is not surprising that there is variation in final pelvic form both within and across populations. Because of this variation, the pelvic measures that appear to be sexually dimorphic also differ by population. But perhaps more interesting than this variation in dimorphism, is the consistent dimorphism of some pelvic measures under varying environmental circumstances. For this study, 23 pelvic measurements were collected from 669 individuals from six skeletal populations. Each measure was corrected for body size, using the geometric mean of pelvic size, and assessed to determine if the measure was sexually dimorphic in each population. These results were then compared across the populations. Many of the measures were dimorphic in some populations, but not others. However, 11 of the 23 measures were sexually dimorphic across every population: the posterior space of

the inlet, the posterior space of the midplane, the bi-spinous diameter, the anterior space of the outlet, the posterior space of the outlet, the transverse diameter of the outlet, circumference of the midplane, pelvic breadth, iliac height, interiliac breadth, and pelvic depth. Based on these results, it can be argued that these measures are under the strongest selection pressure to remain sexually dimorphic.

### "Rogue" Taxa and Hominin Phylogeny

MANA DEMBO<sup>1,2</sup>, ARNE MOOERS<sup>1,3</sup> and MARK COLLARD<sup>1,2,4</sup>

<sup>1</sup>Human Evolutionary Studies Program, Simon Fraser University, <sup>2</sup>Department of Archaeology, Simon Fraser University, <sup>3</sup>Department of Biological Sciences, Simon Fraser University, <sup>4</sup>Department of Archaeology, University of Aberdeen

Obtaining a well-supported phylogenetic tree for the hominins is an important goal for palaeoanthropology. However, studies have often yielded trees that contain weakly supported relationships. In the study reported here, we investigated whether this is due to some hominin species being "rogue" taxa. Rogue taxa are species that move around in phylogenies and therefore decrease resolution and support levels. This phenomenon is caused by ambiguous or contradictory phylogenetic signal. The goals of the study were a) to identify any rogue taxa, and b) to assess their impact on the support for different nodes.

We began by running a dated Bayesian analysis using a supermatrix of 391 craniodental characters pertaining to 25 taxa from the last seven million years of hominin evolution. Using the resulting posterior distribution of trees we identified rogue taxa using the software RogueNaRok. The species identified as rogues were then removed iteratively in subsequent analyses. We conducted Bayesian analyses with the pruned taxon sets to assess the improvement of nodal support in the resulting phylogenies.

Seven fossil hominin taxa assumed varying and contradictory positions in the phylogenies and therefore were identified as rogue taxa by RogueNaRok. We found a dramatic improvement in nodal support with the removal of any of these taxa, but in particular with the removal of *Kenyanthropus platyops*, *Homo naledi*, and *Homo floresiensis*. A careful consideration of these rogue taxa and their characters may improve the overall accuracy and support for hominin phylogenies.

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### The Complexities and Interpretive Benefits of Employing Local Food Resources for Dietary Reconstruction via Stable Isotope Analysis

SOPHIA C. DENT and DALE L. HUTCHINSON

Anthropology, University of North Carolina at Chapel Hill

Comparing stable isotope values of human biomaterials to isotope values of local food resources enhances the interpretive resolution of dietary reconstruction. An interpretive baseline for dietary reconstruction can be established by analyzing isotope values of food resources local to the regions of archaeological sites – this includes modern flora as well as modern and archaeological fauna. Establishing isotope values for local resources is important because isotopic ranges used to distinguish plant groups and types of animal protein can vary according to local ecology and isotope mixing systems. Hutchinson's stable isotope analysis of human biomaterials from the Palmer Site indicated low  $\delta^{15}\text{N}$  values ( $10.9 \pm 0.6\text{‰}$ ) of Palmer individuals compared to other coastal populations in Florida. Comparing the values of these human biomaterials to the interpretive baseline of local resources revealed that the marine fish from the region local to Palmer were depleted in  $^{15}\text{N}$  ( $9.5 \pm 1.7\text{‰}$ ), which contributed to the low  $\delta^{15}\text{N}$  values of Palmer individuals.

An additional case study employed for this poster shows higher  $\delta^{15}\text{N}$  values of marine fish in coastal North Carolina ( $12.9 \pm 3.1\text{‰}$ ) compared to Gulf coast Florida, which highlights isotopic differences in resources even in similar ecosystems in the southeast United States. These differences can skew dietary interpretations. Establishing a local baseline is not without challenges, and this poster will also discuss the complexities of reconstructing past isoscapes, such as factors (e.g. land development, fertilizer use) that affect the comparability of past and modern food resources, and how to best account for them.

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### MtDNA analysis reveals presence of ancestral lineages between coastal and highland populations in Papua New Guinea

KATE L. DEROSA<sup>1,2</sup>, MIAN LI<sup>2,3</sup>, HAYLEY MANN<sup>1,2</sup>, STEPHEN SCHUTTA<sup>1</sup>, AMANDA ROOME<sup>1,4</sup>, WEIYI GUO<sup>1</sup>, DANIEL CASTELLANOS<sup>1</sup>, SAMANATHA BENDER<sup>1</sup>, JESSICA ECHART<sup>1</sup>, KALEN CASEY<sup>1</sup>, MICHEL SHAMOON-POUR<sup>1</sup>, HARRISON DULIN<sup>1</sup>, RITA SPATHIS<sup>1,2,4</sup>, RALPH M. GARRUTO<sup>1,3,4</sup> and J. KOJI LUM<sup>1,2,3</sup>

<sup>1</sup>Anthropology, Binghamton University, <sup>2</sup>Laboratory of Evolutionary Anthropology and Health, Binghamton University, <sup>3</sup>Biology, Binghamton University,

<sup>4</sup>Laboratory of Biomedical Anthropology and Neuroscience, Binghamton University

Nearly 1/6th of the world's languages are spoken in New Guinea, reflecting its Pleistocene settlement and rugged mountainous interior. Archaeological evidence indicates trade of obsidian and shells, suggesting contact between the highland and coastal populations and thus potential gene flow between them.

We generated mtDNA HVSI sequences from 1,000 samples from early contact highlanders in 17 villages (n=50 each) representing 14 languages of the Trans-New Guinea Language Phylum. These data were then compared to those from eight coastal East Sepik Province populations to assess levels of gene flow between the two regions.

Preliminary analysis reveals the presence of shared mtDNA lineages between the eastern and southern highland and coastal populations. There is at least one lineage ancestral to all three geographic regions, determined by  $\geq 50\%$  of all populations within the geographic regions containing the same motif. Migration appears to be most prevalent between the southern highlands and the coast, as there are eight lineages within both regions  $\geq 25\%$ . Coalescent analysis of age supports the presence of ancestral lineages as the exclusion of the shared lineages increases age significantly for all groups except for the highland P haplogroup. This suggests the networks for all haplogroups, aside from highland P, become more dispersed and less related upon shared lineage exclusion, indicating the shared lineages are ancestral in nature. Thus trade routes between coastal and highland populations of New Guinea potentially provide routes for gene flow observed between highland and coastal populations.

*Funding for this research was provided by the National Geographic Society Genographic Project.*

### High Fat, High Protein Diet Increases Bone Density in Cold-exposed Mice: Implications for Humans

MAUREEN J. DEVLIN, AMY E. ROBBINS, MIRANDA N. COSMAN, LILLIAN M. SHIPP and TIMOTHY R. BRASH

Anthropology, University of Michigan

Temperature may alter human skeletal acquisition. Previously we showed that cold exposure reduces bone mass in a mouse model of humans. Although the mechanism is not well understood, there is some evidence that cold-induced bone loss can be reduced by nonshivering thermogenesis (NST) via uncoupling protein in brown adipose tissue. Recently a second NST pathway via creatine cycling was identified. This pathway may be particularly relevant for humans, since cold-dwelling populations tend to eat a high protein, high fat diet abundant in

creatine. Here we test the hypothesis that high protein, high fat (HFHP) diet increases NST and reduces bone loss during cold exposure. We housed wildtype C57Bl/6J male mice in pairs at 78°F (thermoneutrality), 72°F (mild cold stress), and 68°F (moderate cold stress) from 3-6 wks of age. Mice were fed a normal diet (N) or high fat, high protein diet (HFHP) ad libitum (N=6-8/group). Results indicate that HFHD mice have longer femurs vs. N mice at all three temperatures ( $p < 0.05$  for all). At 68°F, BMD and body fat were higher in HFHD vs. N mice, but these effects were not seen in mice at 72°F or 78°F ( $p < 0.05$  for both). Preliminary microcomputed tomography of cortical and trabecular bone architecture at the midshaft and distal femur suggests that HFHP mice have lower bone volume fraction, with fewer, thicker trabeculae vs. N, irrespective of temperature. These data demonstrate that high fat, high protein diet has complex effects on body composition, bone mass and architecture during cold exposure.

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### Bayesian Tip-dating of Caviomorph Rodent Phylogenies provides New Age Estimates for South America's oldest Platyrrhines

DORIEN DE VRIES<sup>1</sup> and ERIK R. SEIFFERT<sup>2</sup>

<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, <sup>2</sup>Department of Cell and Neurobiology, University of Southern California

The timing of the arrival of platyrrhine anthropoids on the South American continent remains poorly dated. The late Eocene age that was originally proposed for the Santa Rosa local fauna in Amazonian Peru, which has yielded the oldest platyrrhine (*Perupithecus*), is based on the "stage of evolution" of the associated marsupials and rodents and its geological location underlying the Mio-Pliocene Madre de Dios Formation, but a younger (Oligocene) age has also been suggested. In order to further our understanding of the antiquity of the South American platyrrhine radiation, a more objective dating method is needed. Here we present the results of a Bayesian 'tip-dating' phylogenetic analysis of caviomorph rodents, using morphological data and uniform priors on taxon ages to simultaneously estimate phylogeny and the ages of included taxa. Mean age estimates for each taxon are averaged on a locality-to-locality basis to provide an age estimate for each locality. With a broad uniform late Eocene to Oligocene (37.8 to 23 Ma) prior on the age of the Santa Rosa rodents, two of four species were placed near the Eocene-Oligocene boundary (33.7 and 34.7 Ma), one was placed in the early Oligocene (32.6 Ma), and another was placed in the late Oligocene (24.7 Ma). The mean of these heterogeneous estimates is 31.42 Ma, approximately midway through the early Oligocene (Rupelian) and near the close of the

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Tinguirirican SALMA. These results suggest that an early Oligocene age for *Perupithecus* is more likely than a late Eocene age.

### Sleep tree use by emperor and saddleback tamarins during the dry season: A test of food resource exploitation as a driving factor

MATTHEW DE VRIES<sup>1,2,3</sup>, MRINALINI WATSA<sup>3,4</sup> and GIDEON ERKENSWICK<sup>3,5</sup>

<sup>1</sup>Department of Anthropology, University of Toronto,

<sup>2</sup>School of the Environment, University of Toronto,

<sup>3</sup>Research Department, Field Projects International,

<sup>4</sup>Department of Anthropology, Washington University in St. Louis, <sup>5</sup>Department of Biology, University of Missouri St. Louis

Sleeping tree selection by arboreal primates can influence daily travel costs, intergroup interactions, predation risk, and feeding patterns. We investigated the role of food resource proximity in this decision-making process. We recorded 11 unique sleep trees for one group of emperor tamarins (*Saguinus imperator*) and 11 for one group of saddleback tamarins (*Leontocebus weddelli*), which were followed for 35 and 39 days respectively, between June and August 2016 at Estación Biológica Rio Los Amigos in Madre de Dios, Peru. We baited four trap sites with bananas for several weeks for a mark-recapture program and present here the use of sleep trees both during and outside of this baiting period. We hypothesized that both species would exploit sleep trees closer to trap sites during the baiting period in order to minimize travel effort to a novel fruit source that does not naturally occur. Mean distance in metres from sleep tree to four trap sites was calculated during baiting and non-baiting periods (Example: *S. imperator* Trap1-Baited  $\bar{x}_i=205.857\pm 41.547m$ ,  $n=7$ , Trap1-NotBaited  $\bar{x}_i=174.778m\pm 90.766m$ ,  $n=9$ ; *L. weddelli* Trap3-Baited  $\bar{x}_i=217.667\pm 149.755m$ ,  $n=6$ , Trap3-NotBaited  $\bar{x}_i=190.556m\pm 141.01m$ ,  $n=18$ ). There was no statistical difference between these time periods for *S. imperator* ( $t=0.912$ ,  $p=0.19$ ) or *L. weddelli* ( $t=0.39$ ,  $p=0.354$ ). We suggest that constraints on sleep tree selection, such as tree hole availability and predation risk, may explain these results, given that 2 out of 4 revisited trees contained tree holes habitually occupied by *L. weddelli*. As well, predator avoidance might favour the use of different sleep trees on consecutive nights, which was observed.

National Science and Engineering Research Council, School of the Environment University of Toronto, International Primatological Society.

### Sex differences in pre- vs. post-Black Death trends in survivorship

SHARON N. DEWITTE

Department of Anthropology, University of South Carolina

Previous research revealed declines in survivorship and increases in risks of mortality thus, by inference, declines in general levels of health in London in the period leading up to the Black Death (c. 1347-1351), and improvements in survivorship and declines in risks of mortality in London following the epidemic. These studies used pooled-sex samples. There is, however, reason to suspect that differences in these trends might have existed between males and females. Previous research suggests that females might have been less frail than males at the time of the Black Death but that males faced lower risks of mortality just after the epidemic. This study examines sex-based variation in temporal trends in survivorship to assess whether changes in demography before and after the epidemic were similar for males and females in medieval London. The samples for this study ( $n = 879$ ) come from several medieval London cemeteries and are dated to one of three medieval periods: Early Pre-Black Death (1000-1200 AD), Late Pre-Black Death (1200-1250 AD), or Post-Black Death (1350-1540 AD). Kaplan Meier survival analysis reveals a decline in adult survivorship before the Black Death (Early Pre-Black Death vs. Late Pre-Black Death) for both sexes, and an increase in adult survivorship after the epidemic (Late Pre-Black Death vs. Post-Black Death) for both sexes. These results mirror the trends previously estimated for a pooled-sex sample, and suggest that underlying health declined before the epidemic but improved thereafter for both sexes.

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### Scaling relationships within architectural properties of the jaw adductor musculature in *Macaca fascicularis*

EDWIN DICKINSON<sup>1</sup>, LAURA C. FITTON<sup>2,3</sup> and KORNELIUS KUPCZIK<sup>1</sup>

<sup>1</sup>Max Planck Weizmann Center for Integrative Archaeology and Anthropology, Max Planck Institute for Evolutionary Anthropology, <sup>2</sup>Centre for Anatomical and Human Sciences, Hull York Medical School,

<sup>3</sup>Department of Archaeology, University of York

The forces generated by the masticatory musculature are key to the oral processing of food items; yet conflicting pressures also operate to maintain both a functional gape and adequate jaw contractile velocities. Consequently, the jaw adductor musculature must remain capable of meeting a broad array of functional demands. This structure-function relationship is further complicated by ontogeny, as specific performance variables may be more strongly emphasized at different stages of development. To this end, it has been hypothesized that muscle fascicle lengths will increase during ontogeny, in order to facilitate greater jaw gapes. This study explores the effects of growth upon three parameters (muscle mass,

fascicle length, and physiological cross-sectional area) across a developmental sequence of *Macaca fascicularis*, spanning from unweaned infants to skeletally mature adults. Absolute muscle masses increased consistently during development. This relationship tends towards slight positive allometry within each muscle, and for the adductor complex as a whole; though a significant degree of variation can be observed within the sample. A similar relationship was observed in fascicle lengths across all muscles, with temporalis presenting the greatest relative increases during ontogeny. PCSA scales positively with increasing muscle mass but negatively as fascicle lengths increase. The product of this interplay throughout ontogeny is that jaw adductor PCSA appears to scale isometrically with growth. This relationship suggests that masticatory forces scale closely with body size, an observation which may inform future studies into primate feeding ecology.

This research was funded by the Max Planck Society.

### Male Ranging Behavior and Cooperative Territorial defense in White-bellied Spider Monkeys (*Ateles belzebuth*)

ANTHONY DI FIORE<sup>1,3</sup> and ANDRES LINK<sup>2,3</sup>

<sup>1</sup>Department of Anthropology, University of Texas at Austin, <sup>2</sup>Department of Biological Sciences and School of Management, Universidad de Los Andes, Bogotá, Colombia, <sup>3</sup>Fundación Proyecto Primates

Spider monkeys and chimpanzees are the only primates – apart from humans – where males commonly participate in cooperative territorial defense and coalitionary aggression directed towards groups of neighboring males. From 2005 to 2015, we studied male ranging behavior and intergroup relations among spider monkeys (*Ateles belzebuth*) in Amazonian Ecuador. We recorded more than 60 events associated with intergroup competition, most involving males only but some involving mixed sex parties. These events consisted of coordinated “patrols” of home range boundaries or of the interstices between group ranges, “incursions” into rivals’ territories and direct “encounters” with individuals from neighboring groups. In our main study group – where we know, based on genetic data, that all but one of the resident males are members of an extended patriline – the probability that animals conducted either a patrol or a deep incursion into the territory of a neighboring community was significantly affected by the number of adult males present in the party, and ~1/3 of patrols included all of the community males. Within groups, male-male aggression is virtually nonexistent, but intergroup encounters can escalate to potentially lethal aggression. Only males initiated and participated in aggression during intergroup conflicts, and, as has been found for chimpanzees, the outcome of such encounters was strongly influenced by the relative number

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of males involved. Because of their phylogenetic distance from hominoids, spider monkeys provide a valuable comparative model with which to evaluate the principles underlying male cooperation and coalitionary intergroup aggression that characterizes chimpanzees and humans.

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### Orangutans, Fruit, and the Geometric Framework - Fruit and Non-Fruit Choice in Wild *Pongo pygmaeus wurmbii*

ANDREA L. DIGIORGIO<sup>1</sup> and CHERYL D. KNOTT<sup>1,2</sup>

<sup>1</sup>Anthropology, Boston University, <sup>2</sup>Research, GPOP

Recent evidence suggests that the foraging strategies of Bornean orangutans (*Pongo pygmaeus wurmbii*) cannot be characterized within the optimal foraging framework alone, and that the geometric framework of nutrition may also apply to this species. As we evaluate the role of geometric theory with optimal foraging theory in the diet selection of orangutans, one criticism of the geometric framework is that we cannot be certain that an animal is seeking other food types and not merely eating what they encounter after leaving depleted fruit and while searching for another fruit. To demonstrate that orangutans are indeed selecting non-fruit foods and not only seeking fruit, we expect to see two behaviors: (1) orangutans leaving available fruit crops for non-fruit foods, and (2) orangutans selecting non-fruit foods when fruit is available and nearby. We use data from 51 full-day focal animal follows (611 feeding bouts, 15 focal animals) collected in Gunung Palung National Park, Borneo, from May 2015 – Jan 2016. We find that when orangutans do leave available fruit (n=95) it is significantly more often for non-fruit foods (80/95 occurrences, Exact Binomial,  $p = 3.4e^{-12}$ ). We characterize the nutrient content of fruits that orangutans leave available most often. We also present descriptive GPS data demonstrating that orangutans often leave or even pass by fruit crops to consume other food types. Together, these data suggest that geometric models, in addition to optimal foraging models, may be appropriate to characterize the feeding behavior of wild Bornean orangutans.

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### Modeling the Effects of Multiple Transmission Pathways on the Spread of Enteric Pathogens

JESSICA DIMKA<sup>1</sup>, JAMES TROSTLE<sup>2</sup> and JOSEPH N.S. EISENBERG<sup>3</sup>

<sup>1</sup>Anthropology, Temple University, <sup>2</sup>Anthropology, Trinity College, <sup>3</sup>Epidemiology, University of Michigan

Enteric pathogens kill approximately 500,000 children under five years old annually, particularly affecting developing countries. While most epidemiological studies of these diseases consider consumption of contaminated drinking water or poor sanitation and hygiene, few studies investigate the joint effects of different transmission pathways. Further, cultural norms such as age- and gender-related variation in adoption of interventions also may have unanticipated effects. Demographic, ethnographic and survey data from a study region in northern coastal Ecuador were used to create an agent-based model that simultaneously considers multiple transmission routes, household variation in practices such as water treatment, and individual behavioral heterogeneity. Two potential targets of household-level interventions – water treatment and latrine ownership – were systematically varied across extreme values to determine potential interactions among these practices. Results show that water treatment drives patterns of epidemic size, resulting in smaller peak and final sizes as treatment coverage increases. However, interactive effects are apparent in final size, which drop more markedly when latrine ownership rates are high than when they are low (e.g. 73% to 23% of the population affected at 100% latrine ownership and 56% to 32% affected at 0% ownership). The increased range of outcomes with higher latrine coverage is likely due in part to transmission modeled as contact with contaminated latrine surfaces that becomes more noticeable when water treatment is low, demonstrating the need for clean and well-maintained facilities. These results highlight the importance of public health interventions that take into consideration the relationships between different transmission pathways.

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### Variation in the trabecular bone structure of the proximal humerus in four human populations

LILY J. DOERSHUK<sup>1</sup>, JAAP P.P. SAERS<sup>2</sup>, JAY T. STOCK<sup>2</sup>, COLIN N. SHAW<sup>2</sup>, KRISTIAN J. CARLSON<sup>3,4</sup>, TEA JASHASHVILI<sup>5</sup> and TIMOTHY M. RYAN<sup>1,6</sup>

<sup>1</sup>Department of Anthropology, Pennsylvania State University, <sup>2</sup>PAVE Research Group, Department of Archaeology and Anthropology, Division of Biological Anthropology, University of Cambridge, <sup>3</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California, <sup>4</sup>Evolutionary

Studies Institute, University of Witwatersrand, <sup>5</sup>Department of Geology and Paleontology, Georgian National Museum, <sup>6</sup>Center for Quantitative Imaging, EMS Energy Institute, Pennsylvania State University

Modern humans are more skeletally gracile than other hominin species and most primates. However, the role of repetitive loading during physical activity in determining trabecular bone structure remains unclear. Recent studies have demonstrated that trabecular bone in the proximal femur of foragers is similar to non-human primates, but that agricultural populations fall well below the non-human primate distribution. This project investigates trabecular bone structural variation in the proximal humerus of forager, early agricultural, medieval, and post-industrial revolution human populations. As the upper limb analog to the proximal femur, the proximal humerus is of interest because it is not continuously loaded during locomotion, but experiences forces from multiple directions during various daily activities. Two main questions were posed: how does trabecular bone structure in the proximal humerus vary between human populations with divergent subsistence practices? Does humeral trabecular bone structure mirror patterns observed in the proximal femur? Proximal humeri of 64 adult humans from four distinct populations and 32 primates from 3 species were microCT scanned and centralized volumes of interest were analyzed using Avizo, BoneJ, and SPSS. All human populations have significantly lower bone volume fraction (BV/TV) than *Pan*, *Pongo*, and *Papio*. Within humans, forager and agricultural populations have significantly higher BV/TV and thicker trabeculae than medieval and post-industrial revolution populations. Results indicate reduced skeletal robusticity in the proximal humerus, but do not exactly mirror patterns seen in the proximal femur. This suggests the presence of a non-systemic, biomechanical influence on variation in trabecular structure across skeletal elements.

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### Cortical Area vs Bone Area: Assessing Intracortical and Endosteal Bone Loss With Age

VICTORIA M. DOMINGUEZ<sup>1</sup> and AMANDA M. AGNEW<sup>1,2</sup>

<sup>1</sup>Skeletal Biology Research Laboratory, The Ohio State University, <sup>2</sup>Department of Anthropology, The Ohio State University

Skeletal microarchitecture changes over time, particularly in the ribs where bone loss is a major factor. Bone loss is thought to occur at both the endosteal border, where trabecularization erodes the internal margin of the bone, and intracortically, where Haversian canal number and pore size (due to coalescing remodeling events) increase. Histomorphometric methods often rely on

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measurements of cortical area (CtAr), which while reflective of endosteal changes, cannot account for potential variation in intracortical porosity. Bone area (BAR), however, measures the two-dimensional area of all porosity in a cross-section (PoAr) and subtracts it from the CtAr, resulting in a more precise measure of viable bone area.

This study compares CtAr and BAR, assessing whether they are significantly different and how these two variables align with age. A sample of 75 mid-thoracic ribs (levels 4–7) from 75 individuals (18=females, 57=males), with ages ranging from 15–99 years (mean=49, sd=24) were analyzed. CtAr, PoAr, and BAR were manually collected using a digitizing tablet and percent cortical porosity (%PoAr), which normalizes for variation in rib size, was calculated from said variables. A paired samples t-test showed CtAr and BAR significantly differ. Both variables were then linearly regressed against age, revealing negative trends with in both cases (CtAr  $R^2=0.25$ ; BAR  $R^2=0.31$ ). %PoAr, when regressed against age, revealed a positive trend ( $R^2=0.27$ ). These data support the notion that intracortical porosity increases across the lifespan and indicate that further exploration of the use of BAR rather than CtAr in histomorphometric methods is warranted.

### Some Strepsirrhines Prefer Alcohol

NATHANIEL J. DOMINY<sup>1,2</sup> and SAMUEL R. GOCHMAN<sup>1,2</sup>

<sup>1</sup>Anthropology, Dartmouth College, <sup>2</sup>Biological Sciences, Dartmouth College

Recent field observations suggest that dietary ethanol, or alcohol, is a source of supplemental calories for some primates. For example, slow lorises (*Nycticebus coucang*) consume the fermented nectar of the bertam palm (*Eugeissona tristis*), which has a mean alcohol concentration of 0.6% (range: 0.0 to 3.8%). A similar ecological interaction is inferred for aye-ayes (*Daubentonia madagascariensis*) on the basis of a single point mutation (A294V) in the gene that encodes alcohol dehydrogenase class IV (ADH4), the first enzyme to encounter and catabolize ethanol during digestion. The mutation increases catalytic efficiency 40-fold and may confer a selective advantage to aye-ayes when they consume nectar from the traveler's tree (*Ravenala madagascariensis*), an important wet-season food resource. It is uncertain, however, whether these nectar-feeding primates prefer alcohol or merely tolerate it. Here we report the results of a multiple-choice food preference experiment with two aye-ayes and a slow loris. We conducted observer-blind trials with randomized, serial dilutions of ethanol (0–5%) in standard arrays of *Ravenala* and *Eugeissona* nectar-simulating sucrose solutions. We found that both primate species could discriminate varying concentrations of alcohol; and further, that both species preferred the highest concentrations of alcohol available

to them. These results bolster the hypothesized adaptive function of the A294V mutation in ADH4, and a connection with fermented foods, both in aye-ayes and the last common ancestor of African apes and humans.

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### The Effect of Forest Disturbance on the Feeding Ecology and Behavior of *Varecia variegata* in Ranomafana National Park

MARIAH DONOHUE<sup>1</sup> and PATRICIA C. WRIGHT<sup>2</sup>

<sup>1</sup>Ecology and Evolution, Stony Brook University,

<sup>2</sup>Department of Anthropology, Stony Brook University

The exploitation of primary forests throughout eastern Madagascar has contributed to the decline of sensitive primate species, including the black-and-white ruffed lemur (*Varecia variegata*). Characterized as particularly vulnerable to habitat degradation, *V. variegata* are large-bodied obligate frugivores that exhibit strong preferences for tall trees with large diameter at breast height (DBH). Because this species occupies a wide variety of habitats, it is important to understand how populations with different resource availabilities utilize their ecosystems. We hypothesize that increased disturbance limits viable *V. variegata* food resources, which leads to increased feeding time and consumption of fewer fruit species as compared with populations in pristine habitats. To test this hypothesis, we recorded the amount of time spent feeding and number of plant species consumed in two sites with distinct histories of disturbance. We followed 3 groups in the lightly disturbed site (Vatoharanana) from June 1<sup>st</sup> – June 27<sup>th</sup> (n=35 h) and 4 groups in the pristine site (Mangevo) from June 30<sup>th</sup> – July 15<sup>th</sup> (n= 106 h). Data analysis reveals that the Vatoharanana population allocated 35.4% of their daily budget to feeding, which is significantly higher than the Mangevo value of 29.4% ( $p= .0225$ ). In addition, the Mangevo population consumed 18 species of plants whereas the Vatoharanana population consumed just 3. These results illustrate a meaningful disparity between the populations sampled, thereby contributing to our understanding of how this species reacts to long-term disturbance.

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### Stressful times: Investigating childhood health in urban and rural medieval Britain

ELEANOR R. DOVE, JOEL D. IRISH, CONSTANTINE ELIOPOULOS and ISABELLE DE GROOTE

Natural Sciences and Psychology, Liverpool John Moores University

Urban and rural health differences during childhood are widely reported in modern Britain, with

poorer urban children tending to suffer more from infections, allergies, and malnutrition. This study investigates whether this trend is evident in medieval western Britain.

Two contemporary medieval skeletal collections dated to the 12<sup>th</sup> to 16<sup>th</sup> century were examined; rural Poulton (n=337) from the North West and urban Gloucester (n=202) from the South West. The indicators chosen to evaluate insults to health were: Harris lines (HL), linear enamel hypoplasia (LEH), and cribra orbitalia and porotic hyperostosis (PI). Both HL and LEH occur after a moderate to severe period of ill health, malnutrition, and/or adverse environmental factors. PI is thought to be caused by anemia, resulting from malnutrition and/or parasitic infestations. Fifty-nine percent of the Poulton sample has HL, compared to 72% for Gloucester. The latter has slightly lower levels of LEH with 61%, whereas Poulton has 69%. Both samples exhibit lower levels of PI, with Poulton having 31% and Gloucester 41%. There is no correlation between indicators within the Poulton sample. Gloucester had a moderately high correlation between HL and PI ( $r_s=0.527$ ). The Gloucester sample indicates later life stress compared to Poulton; HL are far more numerous per individual and ranged continuously from ages 5-13. Poulton shows distinct clustering between the ages of 7-11. These results suggest that the medieval urban environment of Gloucester was unfavorable for childhood health, particularly in early adolescence.

### Worldwide modern human morphological variation: exploring the association between morphological modules and climate and geographic distances

KATHLEEN I. DOWNEY<sup>1</sup>, BRIANNE HERRERA<sup>1</sup> and MARK HUBBE<sup>1,2</sup>

<sup>1</sup>Anthropology, The Ohio State University, <sup>2</sup>Instituto de Arqueología y Antropología, Universidad Católica del Norte

Modern human cranial morphological variation across the world is largely a result of neutral evolutionary processes, with selection acting on localized anatomical regions. This scenario holds true when the crania are analyzed as a whole. However, given the modular nature of the human cranium, different anatomical regions may show different evolutionary trajectories and consequently different patterns of structure for the variation observed among populations. Here, we explore these patterns by looking at the association between anatomical modules and climatic variables within 15 geographic regions that show strong correlations with geographic distances when the whole cranium is considered. The analyses used Hanihara's dataset, and includes 7423 adult male skull from 135 populations, measured according to 32 linear metric measurements, which were divided in two major and six minor anatomical regions, covering the face

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and neurocranium. Average morphological differences (defined with Fst estimates) within each geographic region for each anatomical region were correlated with geographic and climatic variables (temperature and humidity). Although the cranium as a whole shows strong correlations with geographic distances, this correlation is weaker for the anatomical regions. For the face and neurocranium, the average difference in temperature between groups within a region explain significant portions of the morphological variation ( $p < 0.05$ ,  $R^2 = 0.17$  and  $0.26$ , respectively). Similar patterns are seen for the minor anatomical regions. These results corroborate the idea that anatomical regions of the cranium followed different evolutionary pathways in modern humans, and support the use of more detailed analytical frameworks to study the origin of worldwide morphological variation.

### Method Development: Enzyme-linked Immunoassay Techniques to Detect Hair Cortisol Concentrations in Afro-textured Hair

JULIUS A. DOYLE<sup>1,2</sup>, ELEANOR BRINDLE<sup>1,2</sup>, DANIEL ENQUOBAHRIE<sup>3</sup> and STEVE GOODREAU<sup>1,2</sup>

<sup>1</sup>ANTHROPOLOGY, UNIVERSITY OF WASHINGTON, <sup>2</sup>CENTER FOR STUDIES IN DEMOGRAPHY AND ECOLOGY, UNIVERSITY OF WASHINGTON, <sup>3</sup>SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF WASHINGTON

Cortisol, a biomarker of stress, is slowly deposited into growing hair strands on the human head. Meyer and Novak (2014) established a method for hair cortisol extraction and analysis, and showed that hair cortisol can serve as an integrated measure of psychophysiological stress activity during the period of hormone incorporation into the hair. Consequently, hair samples of significant length may potentially serve as a reliable marker of stress experienced over a longitudinal span of time.

Of particular interest then is the development of a psychosomatic measure of some daily, pervasive, hypothalamic-pituitary-adrenal axis-inducing stressors that may be experienced by a diverse group of people. The hair sample collection methods offered by Meyer and Novak (2014) however, (i.e. cutting as close to the scalp as possible with scissors,) can be a rather *barbarous* method... as it leaves behind an unattractive bald spot, and is therefore likely to repel potential research participants in future studies, especially those with kinky-coiled hair textures.

We have developed and standardized a participant-friendly and visually-appealing method for hair sample collection, and applied Meyer and Novak's cortisol extraction technique. Specimens were obtained from fifteen Black men who are patrons at a long-time running, private-owned barbershop located in a Seattle district that is known to serve a large number of Black men.

Future research will extend this collection-extraction methodology to research concerning the potential neuroendocrine-moderative effects of resilience in the face of perceived racial discrimination.

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### The Cost of Early Stress in the Later Stone Age: Temporal Variation in the Relationship between Neural Canal Size and Early Mortality Among Adult Foragers

L. ELIZABETH DOYLE

Anthropology, University of Toronto

Neural canal diameter (NC) may reflect stresses experienced during the canal's period of growth, which finishes in late childhood and adolescence. Among Holocene foragers who occupied southern Africa's Southwest Cape, adults with small canals had reduced survivorship. Bioarchaeological evidence indicates a period of social instability between 3000–2000bp in this region, which resolved after 2000bp. Previous research found that average NC also increased significantly after 2000bp. This analysis set out to test whether the risk associated with small NC varied between 3000–2000bp relative to earlier and later centuries.

105 radiocarbon-dated skeletons were sorted into Young Adult (YA, <30 years, N=41) and Mature Adult (MA, 30+ years, N=57) phases based on pelvic indicators and dental wear. Mediolateral NC was measured at T1, T6, L1 and L5 and converted to sex-standardized scores using Principal Components Analysis. Linear regression models were then fit to log-transformed values.

While NC size is collectively stable over time ( $B = 0.00$ ,  $R^2 = 0.023$ , *ns*), separate YA and MA models show that YA values increase significantly ( $B = -0.263$ ,  $R^2 = 0.16$ ,  $p < 0.01$ ), while MA values do not ( $B = -0.081$ ,  $R^2 = -0.005$ , *ns*). In scatter plots of untransformed scores, YA canals are smallest between 3000–2000bp and increase thereafter, driving the rise in overall NC.

Temporal variation in the risk associated with small NC suggests that early buffering by caregivers influenced adulthood survivorship throughout the Holocene until 2000bp, but less so afterwards. Changes underway after 2000bp, including the introduction of livestock, may have improved childhood conditions, decoupling adulthood mortality from early growth.

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### Reinvestigation of the ~4 Ma Yellow Sands of the Mursi Formation

MICHELLE S. M. DRAPEAU<sup>1</sup>, JONATHAN G. WYNN<sup>2</sup>, DENIS GERAADS<sup>3,4</sup>, LAURENCE DUMOUCHEL<sup>5</sup>, CHRISTOPHER J. CAMPISANO<sup>6</sup> and RENÉ BOBE<sup>7</sup>

<sup>1</sup>Département d'anthropologie, Université de Montréal, <sup>2</sup>School of Geosciences, University of South Florida, <sup>3</sup>Centre de Recherche sur la Paléobiodiversité et les Paléoenvironnements, Muséum National d'Histoire Naturelle, <sup>4</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>5</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University, <sup>6</sup>Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, <sup>7</sup>Departamento de Antropología, Universidad de Chile

The Yellow Sands locality was discovered and periodically explored in the late 1960s and early 1970s by the International Omo Research Expedition. It is the type locality for the Mursi Formation, among the oldest sediments of the Omo Group of southern Ethiopia and northern Kenya. With an age of more than 4 Ma, which corresponds to the *Ardipithecus-Australopithecus* transition, it provides an opportunity to better document the environments available in East Africa during this important evolutionary event.

An expedition in 2015 allowed us to relocate all previously documented fossiliferous localities, to triple the faunal collection, and to improve our understanding of the stratigraphy. The newly collected fauna confirms the high proportion of suids and low proportion of bovids and the relative abundance of hippos, elephants, deinotheres, crocodiles, and *Euthecodon*. However, we also found new taxa that were not previously documented in the formation: a large *Sivatherium*, a possible tragulid, a hyena, and a primate. About 120 m of exposed sediments were mapped and two tuff samples were collected at different locations but at a comparable stratigraphic position. One is the previously documented Mursi R-4 tephra, while the other one correlates with the Cholo Tuff from the Mursi Formation exposures at Cholo, ~25 km north, establishing the first correlation between the two localities. Overall, the renewed work in the formation suggests a relatively mesic and closed environment at the Yellow Sands during the Pliocene. The absence of hominins suggests that it may represent a habitat for which they were not adapted.

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### Condition-dependent Scent Signals in Strepsirrhine Primates

CHRISTINE M. DREA

Evolutionary Anthropology, Duke

Olfactory communication is crucial for coordinating animal social and sexual behavior,

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including in primates. Mammalian scent cues contained in excretory products and glandular secretions typically comprise complex blends of numerous compounds. Drawing from our studies in various strepsirrhines, I review how these compounds advertise a wealth of information and address how the behavior of senders and recipients supports information transfer. Encoded within scent signals is information that remains relatively stable over the signaler's lifetime, typically reflecting its species, sex, or individual identity. We have recently extended this list to include the odorant source and the signaler's social structure (including mating system and hierarchical organization) and genetic quality (as revealed by neutral heterozygosity and MHC composition). Olfactory cues also can be more flexible or transient, typically varying with one's diet, season, reproductive state, or health. Additional evidence of condition-dependent information in lemurs now includes social status, reproductive history, contraception, pregnancy, and fetal sex. Presumably energetically expensive to maintain, proof of production costs is largely restricted to experimental work in rodents. Based on our current studies of the dramatic olfactory consequences of injury in lemurs, we suggest that, particularly when energetic resources must be diverted to recovery processes, costs of signal manufacture can be prohibitive. Integrating information about the sender, its signal, and the recipient's response in an ecological and evolutionary context is key to showing the preeminence of olfaction in the lives of strepsirrhine primates.

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### The "Environment" in Gene-Environment Interaction Research: An Anthropological View

WILLIAM W. DRESSLER  
Anthropology, The University of Alabama

Depression has been a fruitful area for the study of gene-environment interaction. A number of candidate genes have been identified and there is a reliable interaction of these genes with several factors, especially childhood adversity (e.g., death of a parent in childhood). Discrete events such as child adversity are, however, only a small part of the "environment" in gene-environment interactions. The aim of this paper is to explore the role of culture in this process, using data collected in an urban community in Brazil. The specific cultural factor examined is cultural consonance, or the degree to which individuals are able to successfully incorporate salient cultural models into their own beliefs and behaviors. In a study of 402 adult Brazilians from

diverse socioeconomic backgrounds, an interaction was observed between recalled childhood adversity and a polymorphism for the 2A receptor of the neurotransmitter serotonin in relation to depressive symptoms ( $p < .05$ ), and that interaction is stronger in lower income neighborhoods. When controlling for cultural consonance in current family life the effect of the gene-environment interaction drops to zero. Further analysis suggests that cultural consonance in family life is a mediator of the effect of the gene-environment interaction on depressive symptoms. Persons reporting childhood adversity in concert with a specific variant of the gene have lower cultural consonance in family life, and in turn report more depressive symptoms ( $p < .001$ ). These results suggest an important role of cultural consonance in explaining the effects of gene-environment interaction in depression.

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### A Taxonomic Scale-explicit Analysis of Brain Size Evolution in the Hominin Clade

ANDREW DU<sup>1,2</sup>, ANDREW M. ZIPKIN<sup>3</sup>, KEVIN G. HATALA<sup>4</sup>, ELIZABETH RENNER<sup>5</sup>, JENNIFER L. BAKER<sup>6</sup>, SERENA BIANCHI<sup>7</sup>, KALLISTA H. BERNAL<sup>1,2</sup> and BERNARD A. WOOD<sup>1,2</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, George Washington University, <sup>2</sup>Anthropology, George Washington University, <sup>3</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>4</sup>Biology, Chatham University, <sup>5</sup>Psychology, Faculty of Natural Sciences, University of Stirling, <sup>6</sup>Center for Research on Genomics and Global Health, National Human Genome Research Institute, National Institute of Health, <sup>7</sup>Neurology, Icahn School of Medicine at Mount Sinai

A large endocranial volume (ECV) relative to other primates is a defining feature of modern humans. Therefore, it is of great interest to understand how this trait arose in our evolutionary history. However, there is no consensus regarding the pattern, rates, and, ultimately, processes involved in driving an increase in hominin ECV. We suggest this is due to a failure to explicitly consider taxonomic scale. Here, we analyze hominin ECV at multiple taxonomic scales to better understand how ECV has evolved on both micro- and macroevolutionary scales. We find hominin ECV evolved gradually through time at the clade level. This trend appears to have been generated by mechanisms operating both within (i.e., population-level, microevolutionary processes) and among hominin lineages (i.e., speciation/extinction events), reflecting differences in the ways selective pressures and evolutionary mechanisms influenced ECV over time. The rate of within-lineage ECV increase was too slow to be accounted for by directional selection alone. This within-lineage pattern likely involved episodes of directional selection interspersed with periods of stasis and/or drift, all of which occur on too

fine of a time scale to be resolved by the current fossil record. All results are robust to ECV measurement and dating error. Our findings illustrate the complicated, multi-causal nature of hominin ECV evolution and the need for future hypotheses to acknowledge and incorporate this complexity. This analytical framework allows us to generate more precise theories that pinpoint when and at what taxonomic level hominin ECV increase occurred, enabling stronger tests of proposed hypotheses.

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### Female and male rhesus macaque red skin coloration in evolutionary context

CONSTANCE DUBUC<sup>1</sup> and JAMES P. HIGHAM<sup>2</sup>  
<sup>1</sup>Zoology, Cambridge, <sup>2</sup>Anthropology, New York University

Sexual signals are often sexually dimorphic, and when this is not the case, it remains unclear whether expression in one sex is the non-functional by-product of selection on the other. Here, we use Tinbergen's four questions to review our knowledge of red skin coloration in female and male rhesus macaques (*Macaca mulatta*). In other Papionins, red skin coloration is a highly sexually dimorphic signal of status, and is thus under male intrasexual selection (Phylogeny). In rhesus macaques, however, the signal is exhibited by both sexes. Male and female signals modulate sexual behavioural responses in opposite-sex conspecifics (intersexual selection). In addition, although signal intensity does not predict dominance rank, it nonetheless appears to have a moderating role in male conflicts (intrasexual selection) (Function). Selection is linear in females, but non-linear in males: the most successful males are high-ranked males exhibiting the darkest colors, i.e. those who are both attractive and intimidating (Function). In both sexes, expression and perceptual discrimination of the signal by sex develops at sexual maturity (Ontogeny). Signal expression is under the control of estrogen (by conversion from testosterone in males) and is exhibited only by sexually receptive individuals during the mating season (Mechanisms). Finally, inheritance is sex-linked, such that females inherit their degree of signal expression from their mother, and males from their father (Mechanisms). Together, this work provides strong evidence that this signal is under independent sexual selection in both sexes.

# ABSTRACTS

## Osteoware: Standardized Skeletal Documentation Software at the Smithsonian Institution

CHRISTOPHER DUDAR<sup>1</sup>, STEPHEN OUSLEY<sup>2</sup>, ERICA JONES<sup>1</sup>, CYNTHIA W. WILCZAK<sup>3</sup>, JOSEPH HEFNER<sup>4</sup>, MADDEN GWYN<sup>5</sup> and DAWN MULHERN<sup>6</sup>

<sup>1</sup>Anthropology, Smithsonian Institution, <sup>2</sup>Anthropology, Mercyhurst University, <sup>3</sup>Anthropology, San Francisco State University, <sup>4</sup>Anthropology, Michigan State University, <sup>5</sup>Anthropology, Grand Valley State University, <sup>6</sup>Anthropology, Fort Lewis College

The need for a computerized data entry system to inventory, document, and manage data from the 18,000+ Native American catalog numbers in the physical collections at the National Museum of Natural History (NMNH), Smithsonian Institution, became critical with the passage of the National Museum of the American Indian Act (NMAIA) in 1989, predating the Native American Graves Protection and Repatriation Act (NAGPRA) by one year. The foundations of a computerized data entry system were developed after the establishment of the NMNH Repatriation Osteology Lab (ROL) using a DOS-based Paradox system with text screens and non-relational flat data tables. From the beginning it incorporated the Buikstra & Ubelaker (1994) "Standards", a refinement of the work started by the Paleopathology Association (PPA) Skeletal Database Committee in 1988. During this time collaboration was on-going between the ROL, the Chicago "Standards" Group, and the University of Arkansas team led by Dr. Jerry Rose who developed the first Standardized Osteological Database, SOD, in FoxPro. The ROL database evolved into a full relational database within a Structured Query Language (SQL) database management system. Some improvements and revisions have been made to the standard data captured over the years and Osteoware has proven to be stable and reliable during 15 years of continuous use, four operating systems, and has collected well over 400,000 records. The data entry interface software and database are available for free from <https://osteoware.si.edu/> and many requests for research data for synthetic studies have been received and fulfilled through application to the ROL.

Grant support received from Smithsonian Institution Web 2.0 Fund and National Park Service, National Center for Preservation Technology and Training (NCPTT).

## Using 4<sup>th</sup> order polynomial curve fitting to assess curvature and allometry of the hallucal facet in extant hominoids and fossil hominins

MADELYNNE M. DUDAS<sup>1</sup> and WILLIAM E.H. HARCOURT-SMITH<sup>2,3,4,5</sup>

<sup>1</sup>Department of Anthropology, New York University, <sup>2</sup>Department of Anthropology, Lehman College CUNY, <sup>3</sup>Division of Paleontology, American Museum of Natural History, <sup>4</sup>Department of Anthropology, CUNY

Graduate Center, <sup>5</sup>NYCEP, New York Consortium in Evolutionary Primatology

The curvature of the medial cuneiform's hallucal facet in small-bodied fossil hominins has been used to support the idea that certain taxa had an opposable hallux. However, it is not well understood how the morphology of the facet is related to body size. We test the hypothesis that the facet's curvature is, intraspecifically, greater in smaller individuals.

Using surface scans mediolateral curves were fitted to dorsal and plantar portions of the facet with CAD software. We used a large sample of extant hominoids (n=160) and available fossil hominin specimens. 4<sup>th</sup> order polynomials were fitted to the curves, and leading polynomial coefficients were extracted. This new technique is a variation on 3<sup>rd</sup> order polynomial curve fitting (PCF) which has been used to measure simpler curves. 4<sup>th</sup> order PCF allows for asymmetry and curvature changes across the surface.

For the extant sample there is far clearer taxonomic separation for the dorsal facet. We conclude that dorsal hallucal facet curvature is likely more diagnostic of grasping potential, an important consideration when faced with fragmentary remains. For the dorsal portion, all fossil specimens fall within the *H. sapiens* range. For the plantar portion *Au. afarensis*, *H. naledi* and StW 573 are closest to the *Pan* mean, but also overlap with the *H. sapiens* upper 1SD limit.

For our combined great ape sample there is a moderate negative correlation between curvature and body size, but no such relationship for *H. sapiens*. This may be important when considering the inferred grasping potential of small-bodied hominins.

## Are frugivores and nectarivores boozers too?

ROBERT DUDLEY

Integrative Biology, University of California, Berkeley

Ethanol obligately derives from the fermentation of simple sugars, and fermentative yeasts are ubiquitous within the phyllosphere. Animals that routinely consume fruits and nectars thus chronically ingest low-level ethanol, although typical concentrations and consumed volumes are not well characterized. The sensory capacity to detect and follow ethanol plumes enables localization of ripe fruits over long distances (as occurs in fruit flies); positive psychoactive responses to ethanol among vertebrate frugivores may increase net caloric gain during feeding via the aperitif effect. Recent paleogenetic reconstruction of one of the enzymes involved in ethanol metabolism (ADH) suggests sustained exposure of hominids over the last 12 MY to dietary ethanol. Patterns of alcohol use by modern humans may simply reflect ancestral sensory biases associating

ethanol consumption with nutritional reward (i.e., the "drunken monkey" hypothesis). Detailed measurements of ethanol concentrations within fruit and nectar, together with comparative behavioral, physiological and genomic data among frugivores and nectarivores, are now necessary to test the generality of this hypothesis.

## Examining Japanese and Hispanic Morphological Similarities Using Geometric Morphometrics

BEATRIX DUDZIK

Anatomy, Lincoln Memorial University

An increase in the percentage of Hispanic people in the United States population has helped fuel research interest in skeletal variation in Central and South America. Additionally, an increase in border crosser deaths in the American Southwest has allowed forensic anthropologists to accumulate a relatively large skeletal metric dataset that can be used for research purposes. This study builds on the Dudzik and Jantz (2016) publication that examined patterns of overlap among Asian and Hispanic groups when performing discriminant function analysis using Fordisc. Instead of using standard measurements, the current study uses coordinate data and geometric morphometric approaches to better identify morphological overlap between Asian and Hispanic crania. Geometric morphometric analyses have become increasingly popular for studies that examine cranial shape. A recent study by Spradley and Jantz (2016) showed that discriminant function analysis using interlandmark distances to estimate population affinity was more accurate when compared to standard cranial measurements. Based on this evidence and common themes in the literature, a more detailed analysis of the morphologic similarities between Asian and Hispanic craniometric data is warranted with this type of data. Samples included coordinate data associated with a subset of the Hispanic sample included in Fordisc as well as individuals from Japan, Thailand, Korea and China. Results of a preliminary analysis indicates that variation among samples can be better identified to pinpoint which dimensions of the cranium are the most variable or similar. The Hispanic samples continue to group near the Japanese, as was found in previous analyses.

## A mitochondrial DNA study of the Beothuk and Maritime Archaic, extinct aboriginal populations from Newfoundland and Labrador

ANA T. DUGGAN<sup>1,2</sup>, ALISON HARRIS<sup>3</sup>, STEPHANIE MARCINIAK<sup>1,2</sup>, INGEBORG MARSHALL<sup>3</sup>, VAUGHAN GRIMES<sup>3</sup> and HENDRIK POINAR<sup>1,2</sup>

<sup>1</sup>Anthropology, McMaster University, <sup>2</sup>McMaster Ancient DNA Centre, McMaster University,

<sup>3</sup>Archaeology, Memorial University of Newfoundland

## ABSTRACTS

The culture and wisdom of aboriginal populations are under threat in modern society and we know even less about aboriginal populations of the past. With a combined approach of genetic and isotopic data, we are attempting to answer questions of the settlement of the east coast of North America and the relationship between two populations, the Maritime Archaic and Beothuk, who lived in the Canadian province of Newfoundland and Labrador from approximately 7500 – 150 YBP. The Maritime Archaic people were resident in the area from around 7550 - 3200 YBP while the Beothuk, who were the European contact population, appear in the archaeological record only around 2000 YBP and are believed to have gone culturally extinct with the death of Shanawdithit in AD 1829. We have recovered the complete mitochondrial genomes of 75 individuals belonging to these cultures and the data indicate a surprising degree of diversity within these populations but also suggest that there was no maternal continuity between the groups, indeed they may not have even shared a common source population. This project has broad implications for our knowledge of the peopling of the Americas, especially given the dearth of available data from the northeast, and on a local level allows us to reconstruct the ancestry and history of the people who came before. While genetic data cannot recreate cultural information, it can inform us as to the history of these populations and allow us to examine their relatedness with other aboriginal populations, both extinct and extant.

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### Paleoecological reconstructions of c.4 Ma hominin sites from the Omo-Turkana Basin using fossil Bovidae

LAURENCE DUMOUCHEL<sup>1</sup> and RENÉ BOBE<sup>2</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University, <sup>2</sup>Departamento de Antropología, Universidad de Chile

*Australopithecus anamensis* lived in eastern Africa c.4 million years ago. Three main fossil sites in the Omo-Turkana Basin (Kanapoi, Allia Bay and Mursi) preserve sediments of that age. Preliminary paleoecological analyses suggest that there were differences in the environments of these three sites. In addition, the abundance of hominin fossils at these sites is extremely variable; the majority of the fossils attributed to *Au. anamensis* have been found at Kanapoi (c.70%), some have been discovered at Allia Bay (c.30%) and no hominin remains have been found so far at Mursi. Can the differences in the relative abundance of *Australopithecus anamensis* in the Omo-Turkana Basin be attributed to ecological differences between the sites?

This study focuses on fossil Bovidae, a taxon commonly favored for paleoecological analyses.

Overall, the study of the bovid remains reveals that the site of Kanapoi was the most open in vegetation cover, the site of Allia Bay was a more balanced mosaic, and the environment was more closed at Mursi. The bovid community composition differs accordingly and is significantly different between the three sites. Browsers are more common at Mursi than at the other sites and grazers are the most common at Kanapoi. Similarly, carbon isotopic ratios are generally more depleted at Mursi, intermediate at Allia Bay and less depleted at Kanapoi. Allia Bay mesowear scores and ecomorphologic analyses are also indicative of a mosaic habitat at Allia Bay. Analysis of the complete fauna will provide further insights into the preferred habitats of *Australopithecus anamensis*.

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### Effect of mycobacterial species on immune cells and its potential impact on inflammatory responses in periosteal lesions

MEGAN E. DUNCANSON<sup>1</sup>, SHARON N. DEWITTE<sup>2</sup> and FABIAN A. CRESPO<sup>1</sup>

<sup>1</sup>Anthropology, University of Louisville, <sup>2</sup>Anthropology and Biology, University of South Carolina

Individuals who can mount a strong inflammatory response can produce a shift in the systemic levels of inflammatory mediators when exposed to chronic infections, which leads, in turn, to a potential hyper-inflammatory state or hyper-inflammatory phenotype (HIP). Consequently, the systemic immunological shift could affect other persistent infections such as the one observed in periosteal lesions, which are commonly attributed to the pathogen *Staphylococcus aureus*. The objective of this study is to determine if *in vitro* immune cells exposure to bacterial lysates from different species of Mycobacteria (*Mycobacterium tuberculosis*, *M. leprae*, or *M. bovis*) impacts subsequent immune responses to persistent/local pathogen *S. aureus*. During a two-day experiment, we exposed human peripheral blood mononuclear cells (PBMCs) to either *M. tuberculosis* or *M. leprae* or *M. bovis* lysates on day one; sequentially on day two, we exposed the same culture to *S. aureus*. The expression of key proteins (TNF $\alpha$  and IFN $\gamma$ ) involved in the immune response was measured by ELISA. Preliminary results showed that early exposure (day 1) to most mycobacterial lysate induces higher IFN $\gamma$  expression when the same cells are exposed to *S. aureus* (day 2). Interestingly, early exposure to *S. aureus* altered IFN $\gamma$  expression when cells subsequently were exposed to *M. tuberculosis* or *M. leprae* lysates. These preliminary results show an immunological alteration when PBMCs are alternatively exposed to two different pathogens.

These findings could be useful in osteological analyses when considering how tuberculosis or leprosy infection can affect other osteological lesions through the promotion of a HIP.

### Nutritional balancing among Angola black and white colobus monkeys (*Colobus angolensis palliatus*) in structurally distinct areas of the Diani Forest, Kenya

NOAH T. DUNHAM

Anthropology, The Ohio State University

Recent studies have examined nutritional intake strategies of several nonhuman primate taxa. While it is clear that considerable interspecific variation exists with regard to the ratios of non-protein energy (NPE) to protein energy (PE) consumed, the degree to which nutrient intake patterns differ intraspecifically and with regard to differences in habitat is underexplored. This research investigates nutritional intake among individuals (n = 8 adult females, 3 adult males) in three groups of Angola black and white colobus inhabiting structurally distinct areas of the Diani Forest, Kenya, with the null hypotheses of no difference between males and females or among forest areas. Behavioral data were collected from July 2014 – December 2015 (n = 183 days) and combine scan sampling and individual focal-follows to yield estimates of daily macronutrient intake. Standardized laboratory analyses and infrared reflectance spectroscopy were used to quantify macronutrient composition of ~400 foods. Across all groups, females consumed significantly more kilocalories per day than males (p < 0.01). Group diets differed considerably with regard to plant species: mean dietary overlap = 10.4%. Individuals from groups inhabiting more degraded areas consumed significantly less NPE, PE, and total energy per day compared to individuals in more intact forest (p < 0.01 for all comparisons). Despite these significant differences, individuals maintained remarkably consistent balances of NPE to PE: ratios ranged from 1.3:1 - 1.6:1 for females and from 1.4:1 - 2.2:1 for males. Previous research of *Colobus guereza* reported a similar NPE:PE, suggesting *Colobus* spp. nutritional targets may be strictly regulated.

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### Evaluation of the covariation in markers of robusticity in the locomotor skeleton

TYLER E. DUNN

Anthropology, University of Illinois at Urbana-Champaign

Skeletal robusticity has been defined, most broadly, as the massiveness of the skeleton.

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Various analyses analyzing skeletal robusticity, however, do so using a variety of markers falling into four main groups: linear osteometrics, long bone subperiosteal area, muscle moment arms, and enthesial changes. These markers are not standardized and vary between analyses, yet differences in post cranial skeletal robusticity between populations have been attributed to many aspects of life-history (ie. activity, subsistence, changes in climate, population history). The current analysis tests the assumption that various measures of skeletal robusticity are in fact measuring the same aspects of morphological change and evaluates how these different metrics correlate and covary with one another. Each of these methods of assessing robusticity is evaluated in five archeological skeletal assemblages from Northern China (n=135 individuals) dating from 1650-3000 BP for the tibia, femur, and bi-iliac breadth. Each of the markers of robusticity have slightly different patterns of correlation. A significant amount of the variation within each robusticity marker can be explained by other markers of robusticity, indicating that these variables are interrelated and the relationship between them are more nuanced than typically assumed. These findings suggest that the metrics used to evaluate skeletal robusticity need to be cross-validated in a global sample to more accurately construct activity patterns or evolutionary histories of past populations.

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### Human races are not the same as dog breeds: Dismantling a powerful popular metaphor as an educational exercise

HOLLY DUNSWORTH<sup>1</sup>, ABIGAIL BIGHAM<sup>2</sup>, HEATHER NORTON<sup>3</sup>, LAUREL PEARSON<sup>4</sup> and ELLEN QUILLEN<sup>5</sup>

<sup>1</sup>Sociology & Anthropology, University of Rhode Island, <sup>2</sup>Anthropology, University of Michigan, <sup>3</sup>Anthropology, University of Cincinnati, <sup>4</sup>Anthropology, The Pennsylvania State University, <sup>5</sup>Genetics, Texas Biomedical Research Institute

Comparing humans to dogs is probably something humans have done since dogs started living with us. But more recently, and at the population level, Plato pondered it and Darwin threaded the theme throughout *The Descent of Man*. And, as an integral part of Darwin's legacy, particularly when it comes to understanding "race," J.B.S. Haldane posed a question to a group of anthropologists at the Royal Society in 1956 that reads as if it were posed yesterday: "Are the biological differences between human groups comparable with those between groups of domestic animals such as greyhounds and bulldogs...?" Haldane's question begs for an answer because it could significantly impact our understanding of "race"—particularly in the U.S. where dogs are part of our daily lives,

and where the president, born of an indigenous Kenyan father and a white American mother, has referred to himself as a mutt. To that end, we compared published genotypic and phenotypic variation of human races and dog breeds, as well as the processes of admixture and interbreeding, all within the contexts of human and dog origins and evolutionary histories. As a result of this exercise, we demonstrate that comparing the differences between human races, like black and white, to the differences between dog breeds, like Doberman and husky, are largely rooted in poetry or prejudice, not biology.

### Extraction of cortical area thickness profiles from CT-scanned femurs

JÁN DUPEJ<sup>1,2</sup>, ALIZÉ LACOSTE JEANSON<sup>1</sup>, JAROSLAV BRŮŽEK<sup>1</sup> and JOSEF PELIKÁN<sup>2</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>2</sup>Department of Software and Computer Science Education, Faculty of Mathematics and Physics, Charles University

The diaphysis of long bones responds to biomechanical loading by remodeling. Thus a quantified description of the geometrical properties of long bones, such as their cortical area (CA) thickness can help improve the understanding of the functional adaptation process, activity patterns and biological variations. Because on these surfaces landmarks are scarce, ordinary geometric morphometrics cannot be directly applied.

Several algorithms have been proposed to extract dense CA profiles from femoral diaphysis. Some disregard bone curvature, or do not take measures to enforce correspondence. Others focus on the creation of finite element models. We present a workflow for morphometric analysis of femoral CA profiles that takes medial axis curvature into account and performs a simple correspondence search. Minimal user interaction is required.

We demonstrate our approach on a sample of 66 CT scans of the lower limb and construct mean CA thickness profiles of the right femur for both sexes. We also identify the areas in which sexual dimorphism is statistically significant. In our sample, males possessed overall thicker cortex with a peak in posterior direction reaching 10 mm. In females, that peak barely exceeded 8 mm. In all orientations, except lateral, that difference was significant. An inspection of normalized profiles suggests that while males generally have a sharper spike of CA thickness in posterior direction, females have a more even distribution of cortical bone around the medial axis.

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### Teaching Forensics in the Classroom: Considerations for Ancestry Determination in Educational Settings

ALEXIS R. DZUBAK and COLLEEN CHEVERKO  
Anthropology, The Ohio State University

Many courses in biological anthropology teach students to create biological profiles for skeletons. Often, undergraduate or high school students are taught using casts because institutions may not have access to real skeletal remains. Even if skeletal remains are available, casts may be used to minimize damage and to practice skills before applying them to bones. While this practice is good to preserve and respect the human remains, the use of casts in teaching ancestry may be misleading in a teaching context because some of the casts may be atypical for the groups they represent. This poster addresses how typical these casts are of their group using metric analyses. Canonical discriminant functions were performed using all data in Fordisc 3.1 and a separate dataset including Howells data. Two observers independently measured 25 cranial measurements on six ancestry casts purchased from Bone Clones. Although two of the six casts classified correctly with low typicalities and posterior probabilities, all casts were atypical of any group represented in either of the databases in Fordisc. This finding was supported using the additional dataset. All casts represented individuals who are two or more standard deviations from any group mean. Therefore, the ancestry casts display variations of selected traits associated with particular ancestral groups but may not be typical of those groups or represent broader human variation. In a teaching environment, this limitation should be acknowledged so students are able to apply a biological profile to varied contexts.

### Minor Physical Anomalies as Additional Indicators of Developmental Disorder in LB1 from Liang Bua, Flores

ROBERT B. ECKHARDT<sup>1</sup>, SAKDAPONG CHAVANAVES<sup>1</sup> and MACIEJ HENNEBERG<sup>2</sup>

<sup>1</sup>Laboratory for the Comparative Study of Morphology, Mechanics and Molecules, Kinesiology, Pennsylvania State University, <sup>2</sup>Anthropology and Comparative Anatomy, University of Adelaide

Human bones excavated at Liang Bua, Flores, Indonesia, were assigned to the new taxon "*Homo floresiensis*" although coexisting with *Homo sapiens* populations elsewhere. LB1 features (very low endocranial volume, short femora, flaring ilia, etc.) emphasized as diagnostic of a new hominin species are accompanied by other anomalous signs not noted initially, including craniofacial and other asymmetries. Contrasting explanations of brain and body sizes and proportions in LB1 overlook the significance of smaller-scale traits commonly referred to by clinical morphologists as minor physical anomalies (MPAs). Hospital

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surveys conducted by Merks and colleagues in the Netherlands scored patients for traits in 29 major anatomical areas subdivided into 98 smaller regions including a total of 683 single anomalies. In adapting the traits surveyed to LB1 limited skeletal remains we compared only subsets (74 traits) that pertained to the head: Neurocranium size (2 traits), shape (6), sutures (6), face (20), upper jaw (7), lower jaw (5), palate (10), teeth (18). After eliminating small endocranial volume and other disputed features, LB1 exhibited 7 MPAs, including brachycephaly, plagiocephaly, palate form, plus asymmetries in the face, upper jaw, lower jaw, and teeth. Most clinical MPA studies do not record occurrence over the threshold of  $\geq 3$  traits indicating an elevated likelihood of major malformation, but one showed that 36.7% of mentally retarded children had  $\geq 5$  MPAs while no control had  $\geq 5$ . Above-threshold MPA trait occurrence in the greatly restricted subset scored for LB1 remains completely consistent with Down syndrome and independently signals developmental abnormality regardless of specific diagnosis.

### **Gorilla Social Dynamics: Only Heterosexual Relationships Impact Long-Term Stress in Captive Western Lowland Gorillas (*Gorilla gorilla gorilla*)**

ASHLEY N. EDES<sup>1</sup>, BARBARA A. WOLFE<sup>2</sup> and DOUGLAS E. CREWS<sup>1</sup>

<sup>1</sup>Anthropology, The Ohio State University, <sup>2</sup>Executive Board, Morris Animal Foundation

Sociality and gregariousness ameliorate negative effects of stress. For example, social networks are associated with lower basal cortisol and reduced mortality risk among baboons, dampened stress responses in marmosets, and better health and longer lifespans in humans. In this study, we examined the impact of social relationships on physiological dysregulation in gorillas. We estimated physiological dysregulation using an allostatic load index composed of seven biomarkers: albumin, cortisol, corticotropin releasing hormone, dehydroepiandrosterone-sulfate, glucose, interleukin-6, and tumor necrosis factor- $\beta$ . For females, we predicted same-sex relationships would buffer allostatic load, while heterosexual relationships would increase allostatic load. For silverbacks, no association between male-female relationships and allostatic load was expected. Using scan sampling, we recorded proximity ( $\leq 5$ m) for three breeding groups housed at the Columbus Zoo ( $n=11$ ). Total scans per gorilla ranged from 60-1428. Hypotheses were tested using linear regression with percent of time spent in proximity as the independent variable and allostatic load as the dependent variable. There was no significant association between allostatic load and female-female relationships ( $p=0.247$ ,  $R^2=0.084$ ). However, percent of time spent in proximity to the

silverback significantly predicted female allostatic load ( $p=0.036$ ,  $R^2=0.470$ ). Higher allostatic load in females may be due to risk of courtship aggression from males, and same-sex relationships do not appear to buffer those effects. There was no association between male allostatic load and percent of time spent in proximity to females ( $p=0.694$ ,  $R^2=-0.572$ ). Because females are much smaller than and submissive to the silverback, it is unlikely their proximity is perceived as a stressor.

### **Midline Bony Landmarks are Poor, but better than Soft Tissue Landmarks, for Estimating Population Affiliation in Unknown Individuals**

HEATHER J.H. EDGAR<sup>1,2</sup>, KIELA GWIN<sup>2</sup> and KATE RUSK<sup>2</sup>

<sup>1</sup>Maxwell Museum of Anthropology, University of New Mexico, <sup>2</sup>Anthropology, University of New Mexico

Cranial landmarks are used extensively in forensic anthropology to estimate race and ethnicity in unknown individuals. However, most studies associating cranial landmarks with soft tissue structures, which presumably reflect population affiliation, come from orthodontic or facial recreation research, which tends to focus on individuals primarily of European background. We examined orthodontic lateral cephalograms to ask two questions: 1) are bony midline landmarks or soft tissue profile landmarks useful for estimating population affiliation, and 2) which dataset provides greater accuracy?

Our sample consisted of New Mexican females over age 16: 36 European (EA), 32 Hispanic (HA), and 24 Native Americans (NA;  $n=106$ ). We calculated 2D Procrustes coordinates for bony and 13 soft tissue landmarks. Forward stepwise variable selection was used to find the most informative coordinates, which were then used in linear discriminant analysis. Leave-one-out cross-validation was used to estimate the predictive accuracy of each resulting linear classifier.

Bony landmarks correctly classified 60.4% of individuals: 65.7% EA, 50% HA, and 66.7% NA. Soft tissue landmarks correctly assigned 50.6% of individuals, 68.6% EA, 40.6% HA, and 37.5% NA. Overall, these results provide little indication that midline landmark analysis is valuable in estimating group membership, at least when one group represents an admixed sample of other groups in a comparison. However, it is interesting to note that accuracy is significantly greater from bony landmarks. This result may indicate that information provided by soft tissue complicates, rather than clarifies, any facial features associated with race or ethnicity in living persons.

### **Masticatory loading and diet type in relation to cross-sectional geometric properties of the primate zygomatic arch**

HALLIE M. EDMONDS

Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University

During feeding, relatively high magnitude loads of parasagittal bending and torsion can occur along the primate zygomatic arch. It is unclear, however, how these load types pattern by arch location and whether certain diet types induce relatively greater instances of bending and/or torsion during feeding. This study presents a comparative analysis of zygomatic arch cross-sectional geometric properties, interpreted in the context of food mechanical properties (FMPs) and dietary mechanical category (i.e., tough, hard, soft) based on total consumption percent, to determine if diet affects zygomatic arch structure. The greatest measures of torsional strength ( $J$ ) and resistance to bending moments ( $I_{max}$ ) are expected to occur in anterior arch cross sections given that the highest bending and torsional forces are generally concentrated anteriorly. Relatively larger  $I_{max}$  values are predicted to occur in taxa consuming primarily hard and/or soft foods, while greater  $J$  values are expected to occur in taxa consuming primarily tough foods. Data on cross-sectional images from MicroCT scans of zygomatic arches were collected from 7 species of primates ( $n=61$ ). Data on FMPs and total consumption percent were collected from the literature. Intraspecific comparisons revealed significant differences ( $p<0.01$ ) between arch locations in all but one taxon for  $J$ , and significant differences ( $p<0.01$ ) in all but two taxa for  $I_{max}$ . The highest measures for these variables occurred in anterior regions suggesting both load types are greatest anteriorly as compared to other arch locations. When compared, measures of  $I_{max}$  and  $J$  appear inversely related to the FMP values for all taxa.

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### **Disease and dental wear on the upper Texas coast: Cross-era comparison of Native American Health at site 41GV66**

EMILY A. EDWARDS

Department of Anthropology, University of Texas

The purpose of this research was to understand the cross-era changes in the health of a Native American population from site 41GV66 on the upper Texas coast by analyzing skeletal and dental pathologies. Because the Historic individuals included in this study did not have regular interactions with European settlers until the establishment of a mission in 1756, this study provided valuable insight into the indirect effects of European colonization on Native American health. The remains of 40 individuals from the Archaic, Prehistoric, Protohistoric, and Historic eras were

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analyzed macroscopically and observations were recorded on standard forms. Instances of trauma varied the most between eras. Only one of the 20 Prehistoric individuals but half of the 12 Historic individuals exhibited evidence of trauma. With a chi square value of 13.39 and p value of .005, this change is significant. Additionally, Prehistoric individuals exhibited a greater degree of molar wear than Historic individuals, but fewer caries and abscesses. The changes in health observed in the Native American population between the Prehistoric and Historic eras is concurrent with European expansion during the Historic era. The adoption of subsistence farming is the likely cause of the changes in dental pathologies between Prehistoric and Historic individuals. The significant increase in trauma observed in the Historic individuals is probably a result of altercations with other Native American groups, rather than with Europeans, who did not have a significant presence in the area until 1756.

### From the Shenks Ferry People to the Susquehannocks: Inferring Population History in the Lower Susquehanna Valley from Dental Morphology

DANIEL E. EHRlich  
DEPAS of Mycenae

The people of the Shenks Ferry culture occupied the Lower Susquehanna Valley of Pennsylvania during the Late Prehistoric (1300-1600 c.e.). By the end of the 16th century the Susquehannocks migrated from New York state to the Lower Susquehanna Valley. After a brief period of cohabitation, Shenks Ferry material culture is quickly replaced by Susquehannock material in the archaeological record. This has traditionally been interpreted as evidence of population replacement, yet there is no evidence of violence or destruction. One explanation for this could be that the Shenks Ferry people were assimilated into the Susquehannock population. A biological distance study provides a means to investigate group interactions in the Lower Susquehanna Valley.

In this study, I compared dental non-metric traits of Shenks Ferry (n=111) and Susquehannock (n=65) groups diachronically to test the scenarios of population replacement or incorporation. Following standard procedures, I assessed crown and root features of the adult dentition and used mean measure of divergence, along with Robust Estimator of Grade Difference (RED) to calculate distance statistics and assess significance. Despite relatively small distance values most Shenks Ferry and the Susquehannock groups formed distinct clusters, which supports the archaeological evidence of replacement. However Shenks Ferry groups showed greater intra-population variation, which could indicate that some sites of a different culture are

misattributed to the Shenks Ferry culture. As this research demonstrates, biological distance studies can provide additional evidence to evaluate traditional models and provide new insights and interpretations for studies of group interaction and population histories.

### Costs of reproduction assessed via telomere length and epigenetic age measures of biological senescence in young adult women from Cebu, the Philippines

DAN T.A. EISENBERG<sup>1,2</sup>, M. GEOFFREY HAYES<sup>3,4,5</sup>, THOMAS MCDADE<sup>5,6</sup>, CALEN P. RYAN<sup>5</sup>, ALEX GEORGIEV<sup>5</sup>, MEAGHAN JONES<sup>7</sup>, MICHAEL S. KOBOR<sup>7</sup> and CHRISTOPHER W. KUJAWA<sup>5,6</sup>

<sup>1</sup>Department of Anthropology, University of Washington, <sup>2</sup>Center for Studies in Demography and Ecology, University of Washington, <sup>3</sup>Division of Endocrinology, Metabolism and Molecular Medicine, Department of Medicine, Northwestern University Feinberg School of Medicine, <sup>4</sup>Center for Genetic Medicine, Northwestern University Feinberg School of Medicine, <sup>5</sup>Department of Anthropology, Northwestern University, <sup>6</sup>Institute for Policy Research, Northwestern University, <sup>7</sup>Department of Medical Genetics, University of British Columbia

Evolutionary theory predicts that reproduction carries substantial costs that compete with somatic maintenance and thereby accelerate aging. While studies from both humans and experimental animal models broadly support this hypothesis, the pathways via which these physiological costs manifest remain unclear. Telomere length (TL) and epigenetic age provide new opportunities to probe two independent links between human reproduction and senescence. Telomeres are repeating DNA sequences that cap chromosomes, and that shorten with cell replication, oxidative stress and age. Telomere shortening eventually places limits on further cell division, contributing to senescence. Physiological changes which accompany pregnancy, including immune suppression, increased infection risk, cell proliferation related to fluid expansion, and oxidative stress could all accelerate telomere shortening. Horvath's epigenetic clock has been established as highly correlated with age, to be predictive of age-related morbidity and mortality, and to show increases in epigenetic age in those exposed to factors such as HIV and psychosocial stress. We examined whether the number of past pregnancies in 20-22 year old women in the Philippines predicted TL (n=720) and epigenetic age (n=396). Using these samples, we find that parity predicted changes consistent with accelerated aging in both markers: with each additional pregnancy TL was reduced while epigenetic age was increased. Each additional pregnancy predicted the equivalent of 3 years of TL aging in middle age and 0.4 years of epigenetic aging. These findings are consistent with the expectation that reproduction carries physiological costs,

and shows that these effects are detectable even in young adulthood.

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### "What makes us human?" A question to engage students, the public, and research

ANDREA R. ELLER<sup>1</sup> and KERRY M. DORE<sup>2</sup>

<sup>1</sup>Anthropology, University of Oregon, <sup>2</sup>Anthropology, University of Texas at San Antonio

The Socratic method of teaching involves asking and answering questions designed to enhance critical thinking skills and stimulate debate. Arguably, "What makes us human?" is such a question, as the entire field of biological anthropology more or less directly engages with it. Engaging students, scholars, and the public with this question produces a number of valuable outcomes. First, audiences feel connected to the subject of defining humanity with or without scientific or academic training. This relaxes timidity and boosts confidence for understanding complicated material. Second, variation in responses reflects deeply held beliefs about who we are and how our species came to be. Third, audiences enjoy the debate. There is no singular answer to the question after all, and so contemplating and countering the viewpoints of others becomes an important aspect of the process. Here, we report on the use of this strategy in two different settings: anonymous responses posted to an analog university bulletin board, and student responses at the beginning and end of two anthropology courses. To date, we have 297 responses. The responses themselves are a wellspring of data on the social construction of humanity. Emergent themes, revealed in the analyses of responses, indicate frequently evoked ideas such as "creativity", "DNA", or "languages". These common themes offer teachers a natural bridge to classroom materials. We explore the utility of this question as an educational tool, a source of valuable data for researchers of human evolution, and make suggestions for the inclusion of this strategy in educational endeavors.

### Agriculture in the Atacama Desert: Implications for Human Health and Development

GAIL E. ELLIOTT<sup>1</sup>, SIÂN HALCROW<sup>1</sup>, HALLIE BUCKLEY<sup>1</sup>, ANDREW GRAY<sup>4</sup>, VIVIEN STANDEN<sup>2</sup> and BERNARDO ARRIAZA<sup>3</sup>

<sup>1</sup>Department of Anatomy, University of Otago, <sup>2</sup>Departamento de Antropología, Universidad de Tarapacá, <sup>3</sup>Instituto de Alta Investigación, Universidad de Tarapacá, <sup>4</sup>Department of Preventative and Social Medicine, University of Otago

The bioarchaeological model of health change posits a deterioration in health with the development of agriculture. This model is based

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predominantly on findings from North America and European populations, reporting that with the intensification of agriculture there was a deterioration of health due to the increase in population sizes, unsanitary conditions, and the spread of diseases due to close living conditions and proximity to domesticated animals. Greater dependence on plant carbohydrates may have also resulted in nutrient deficiencies, making populations more susceptible to disease and infection. However, some recent work in South America and Asia is challenging this model, suggesting that region-specific factors may influence physiological stress levels. To test this model of deteriorating health this paper presents an assessment of growth disruption as an indicator for physiological stress in prehistoric infants and children from the Azapa, Camarones, and Lluta coastal valleys of northern Chile. This skeletal sample is perfectly placed to test the model for health using growth because it contains high numbers of well-preserved infants and children (N=246), representing well-documented pre- and post-agricultural cultures (ca. 10,000 to 500 B.P.). Dental crown size did not decrease and crown size asymmetry did not significantly increase across the agricultural transition. This finding suggests that health was not adversely affected by the adoption of agriculture in the region, possibly because populations continued to heavily supplement agricultural carbohydrates with marine and terrestrial resources.

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### Fetal Remains in Bioarchaeology: A Case Study from the 19<sup>th</sup> Century Spring Street Presbyterian Church

MEREDITH AB. ELLIS

Anthropology, Florida Atlantic University

The Spring Street Presbyterian Church housed an active abolitionist congregation in lower Manhattan in the 19<sup>th</sup> century, and was well-known for its mixed-class and multiracial parishioners. Construction work in 2006 accidentally unearthed burial vaults associated with the church. The vaults were in use between 1820 and 1850, and contained the commingled remains of some 197 individuals. Seventy of those were subadults from 30 fetal weeks to 15 years of age. This paper will present the results of the analysis of the fetuses, in particular their age distribution, burial contexts, and evidence of lower limb torsion. Recent work in bioarchaeology has encouraged the inclusion of such data from fetal remains. This presentation also integrates the skeletal data with information from archival records that indicate that at least 37 burials are from infants who lived for less than a day.

This analysis sheds light on infant mortality in the urbanizing 19<sup>th</sup> century landscape, particularly

on the intersections of institutions, families, and health. One such example is of a full term fetus buried with a woman in her mid-twenties. This case, when combined with historical records documenting deaths by childbed, allow for an exploration of the challenges urbanization placed on pregnancies, births, and families. The literature surrounding maternity, the documentation of the burials in the records, and the respectful internment of these individuals in the vaults at the Spring Street Presbyterian Church illustrate how complementary resources allow fetal remains to be more fully contextualized and elaborated in the archaeological record.

### Effects of technology on Upper Paleolithic human diet

SIREEN EL ZAATARI<sup>1</sup>, FREDERICK E. GRINE<sup>2,3</sup>, PETER S. UNGAR<sup>4</sup> and JEAN-JACQUES HUBLIN<sup>5</sup>

<sup>1</sup>Department of Paleoanthropology, Eberhard Karls Universität Tübingen, <sup>2</sup>Department of Anthropology, Stony Brook University, <sup>3</sup>Department of Anatomical Sciences, Stony Brook University, <sup>4</sup>Department of Anthropology, University of Arkansas at Fayetteville, <sup>5</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

The Upper Paleolithic (UP) appeared in Europe during the extreme climatic instability of marine isotope stage (MIS) 3. It continued through the severe conditions of the Last Glacial Maximum, and was replaced during the warming trend at the end of MIS 2. The UP is associated with the first appearance of modern humans in Europe and is characterized by unprecedented technological advancements. Compared to earlier technological complexes, the UP exhibits an increase in artifact and raw material diversity and presents an unparalleled rate of innovation and change through time such that, over a period of 30 kyr, distinct techno-complexes such as the Aurignacian, Gravettian and Magdalenian can be identified. This study explores the effects of climatic and cultural changes on the diets of UP humans using dental microwear analysis. We examined occlusal molar microwear textures of 32 adults recovered from 21 European sites in association with the three main UP technological complexes of MIS 3-2. Results suggest that the diets of the UP humans were not significantly affected by climate change. Rather, these people were able to maintain a level of dietary stability, at least within a single cultural phase, in spite of the paleoenvironmental fluctuations. At the same time, however, this analysis reveals changes in diet between earlier (Aurignacian and Gravettian) and later (Magdalenian) UP cultures, suggesting a significant link between technology and diet.

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### Assessing Demographic Change From the Iron Age (7<sup>th</sup> – 4<sup>th</sup> c. B.C.E) through the Roman Period (1<sup>st</sup> – 3<sup>rd</sup> c. C.E.) in Southern Italy Using Isotope and Whole-Mitochondrial Genome Analysis

MATTHEW V. EMERY, ANA T. DUGGAN, HENRY P. SCHWARCZ, HENDRIK N. POINAR and TRACY L. PROWSE

Anthropology, McMaster University

This paper presents the first comprehensive study of two skeletal assemblages spanning the Iron Age through the Roman period (7<sup>th</sup> c. B.C.E. – 3<sup>rd</sup> c. C.E.) in southern Italy, integrating ancient DNA (aDNA) with stable and radiogenic isotope analysis. Assessing demographic change in southern Italy has traditionally relied on archaeological and historic evidence. These lines of evidence, however, cannot establish specific instances of mobility, and fail to identify long-term genetic ancestry over multiple generations. We sequenced the mitochondrial DNA (mtDNA) from 19 Iron Age and 20 Roman period individuals buried at three nearby sites in southern Italy, and measured the <sup>87</sup>Sr/<sup>86</sup>Sr and <sup>18</sup>O/<sup>16</sup>O of composition of 42 molars from the Roman site of Vagnari. The <sup>87</sup>Sr/<sup>86</sup>Sr values of local fauna and soil (n=15) were obtained to determine the regional <sup>87</sup>Sr/<sup>86</sup>Sr baseline to help identify potential outliers at the site. The relationship between <sup>87</sup>Sr/<sup>86</sup>Sr and  $\delta^{18}O$  suggest a relatively low proportion of migrants at Vagnari (~7%), estimated from bivariate analysis. However, mtDNA diversity is shifted from the major European haplogroups (J, T, U, V, K, and H) during the Iron Age to include African (L) and Asian (D) clades during the Roman Imperial period. Together, the biochemical evidence suggests increased mtDNA diversity following Roman conquest and expansion into southern Italy by the 3<sup>rd</sup> century C.E., even with apparently low levels of immigration.

### Longitudinal changes in diet and reproduction among wild chimpanzees at Kanyawara, Kibale National Park

MELISSA EMERY THOMPSON<sup>1</sup>, ZARIN P. MACHANDA<sup>2</sup>, SARAH PHILLIPS-GARCIA<sup>1</sup>, EMILY OTALI<sup>3</sup>, MARTIN N. MULLER<sup>1</sup> and RICHARD W. WRANGHAM<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of New Mexico, <sup>2</sup>Department of Anthropology, Tufts University, <sup>3</sup>Kibale Chimpanzee Project, <sup>4</sup>Department of Anthropology, Harvard University

Studies of chimpanzee reproductive energetics have consistently found that energy balance has a proximate influence on female fecundity, leading to the hypothesis that differences in reproductive rates between populations may be driven by variation in habitat productivity. Variation in feeding ecology and methodology between study sites have made it difficult to test this hypothesis, but evidence for correlated longitudinal changes within a population

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can allow us to rule out competing hypotheses, such as genetic differences. The Kanyawara community of chimpanzees has been studied continuously since 1987, during which time their home range has experienced increases in rainfall and temperature, along with consequences of forest succession and territory reduction. Feeding data collected between 1994 and 2016 indicate little change in the overall proportion of ripe fruit in the chimpanzees' diet. However, component fruit species have changed, particularly *Ficus sur* (or *F. capensis*), which was almost never consumed prior to 2004 but has become one of the most important components of the chimpanzees' diet. Consumption of *F. sur*, more than any other dietary constituent, predicted monthly and interannual variation in energy balance (assessed using C-peptide of insulin levels) in female chimpanzees ( $R^2 = 0.2$ ,  $p < 0.001$ ). The shift in diet was temporally associated with an increase in birth rates. Interbirth intervals beginning prior to 2004 averaged 6.5 years, while those after 2004 averaged only 5.0 years. These data suggest that a relatively moderate change in feeding ecology in a dynamic forest environment can influence primate life history.

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### Make research explicit using RDFBones, an extensible digital standard for research data

FELIX ENGEL and STEFAN SCHLAGER

Biological Anthropology, Freiburg University

A fundamental impediment to the adoption of digital standards in physical anthropology is the vast diversity of this area of research. Even within osteology, many investigations require some modification of existing standards to suit their specific study designs. This might be a reason for researchers not to use database software based exclusively on one particular standard. It also makes it difficult to keep track of research data compatibility and to process data from different investigations in one database system. Up to now, comprehensive and monolithic data standards have failed to address these issues.

We propose a different approach, concentrating on the exact definition of individual data items. These are the building blocks researchers can use to describe the various aspects of their research, like skeletal inventories, research methods and work flows, resulting data and their processing employing mathematical transformations or textual conclusions. Because the building blocks of these descriptions are defined beforehand, the degree of compatibility between different investigations becomes evident.

Our data standard, RDFBones, is an RDF (Resource Description Framework) ontology, containing a number of classes and properties for describing anthropological research and materials. Individual researchers can use these elements to define their methodology, load it in the RDFBones web application and use it to record data according to their own standard. So the software helps building standards, instead of prescribing them. Once a standard is formulated, however, it can be published and shared otherwise, supporting uniform methodology. RDFBones also creates a perfect means for sustained long-term data storage.

This project is funded by the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) under the title "Human Skeletal Collections: Development of Standards for the Access to Historical Anthropological/Anatomical Research Collections".

### Co-evolution of Male and Female Primate Sexual Signals, the Example of Crested Macaques

ANTJE ENGELHARDT

School of Natural Sciences and Psychology, Liverpool John Moores University, Jr. Research Group on Primate Sexual Selection, German Primate Center

In many primate species, males and females both exhibit prominent sexual signals. The function of male sexual signals as well as the co-evolution of signals in both sexes, remains, however, still understudied. Crested macaques (*Macaca nigra*) are one of such examples: males show loud calls and brightly colored scrota, while females exhibit large sex skin swellings and seem to use sexual behavior for signaling. We have studied male and female sexual signals and reproductive strategies more generally over the last decade in three habituated groups of crested macaques in the Tangkoko Reserve, Sulawesi, Indonesia. In this talk, I will summarize the results we gathered on male signals, i.e. their relationship with male dominance rank, their role for male-male contest competition, attraction of and access to females and male reproductive success. I will also present our assessment of the reliability with which female behavior and sexual swellings indicate the timing of ovulation. Subsequently, I will set the function of crested macaque male and female signals as reproductive strategies in relation to each other and discuss the co-evolution of male and female sexual signals in primates more generally.

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### Adolescent Male Aggression toward Adult Females represents Dominance Striving, not Sexual Coercion, in wild Chimpanzees

DREW K. ENIGK<sup>1</sup>, MELISSA EMERY THOMPSON<sup>1</sup>, ZARIN P. MACHANDA<sup>2</sup>, RICHARD W. WRANGHAM<sup>3</sup> and MARTIN N. MULLER<sup>1</sup>

<sup>1</sup>Anthropology, University of New Mexico,

<sup>2</sup>Anthropology, Tufts University, <sup>3</sup>Human Evolutionary Biology, Harvard University

Recent studies demonstrate that adult male aggression toward females in wild chimpanzees often functions as sexual coercion. Adult males can effectively intimidate adult females because of their larger body size and strength, and coercive mate guarding is a particularly beneficial strategy for males of high rank. Adolescent male chimpanzees are neither fully grown nor high ranking, but they can be similarly aggressive to females. Here, we test between two alternative explanations for such aggression by adolescent males. One hypothesis suggests that, like adults, they use aggression for sexual coercion. Alternatively, adolescent males may use aggression primarily to establish social dominance over females. We analyzed aggression data for 12 adolescent males (aged 9-14 yrs) across 23 years of observation at Kanyawara in Kibale National Park, Uganda. We found that, unlike adult males, adolescent males initiated a greater proportion of aggression against females when they were not sexually swollen, lending support to the social dominance hypothesis. As adolescent males aged, they were more likely to win aggressive interactions against adult females. Early adolescents won less than 25 percent, and late adolescents won more than 75 percent of dyadic contests with females. Early adolescents were more successful in aggressive encounters against nulliparous than parous females, but by the end of adolescence, males dominated most parous females. Our findings suggest that female-directed aggression by adolescent male chimpanzees is a necessary precursor to subsequent status striving in the adult male hierarchy.

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### Exploring the impact of collection strategies on interpretations of faunal abundance: a case study from the Koobi Fora Formation (Pleistocene, northern Kenya)

ALYSSA ENNY<sup>1</sup>, MARYSE BIERNAT<sup>1,2</sup>, DAVID R. BRAUN<sup>1,3,4</sup>, WELDEYARED H. REDA<sup>1,5</sup>, ASHLEY S. HAMMOND<sup>1,3</sup>, DAVID B. PATTERSON<sup>1,3,6</sup> and W. ANDREW BARR<sup>1,3</sup>

<sup>1</sup>Koobi Fora Field School, The George Washington University and National Museums of Kenya,

<sup>2</sup>Department of Anthropology, Smithsonian Institution, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>4</sup>Department

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of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>5</sup>Department of Archaeology and Heritage Management, Aksum University, Ethiopia, <sup>6</sup>Department of Biology, University of North Georgia

This study examined the impact of collection protocols on faunal abundance in Pleistocene fossil assemblages. Early work at East Turkana emphasized collecting taxonomically diagnostic material, resulting in an abundance of craniodental specimens in the Turkana Basin Paleontology Database (TBDP). Subsequent research emphasized systematic collection using a Bone Walk (BW) protocol. We explored the impact of these collection strategies by: 1) comparing the percentage of aquatic taxa in the TBDP against recently collected BW data and 2) testing whether the proportional abundance of mammalian families differs in postcranial versus craniodental subsets of the TBDP.

We collected BW data in the Koobi Fora Ridge and Karari Ridge subregions of Koobi Fora Formation from Upper Burgi, KBS and Okote Member sediments spanning 2 – 1.4 Ma. Chi-square analysis compared abundance of aquatic (e.g., fish, hippos, turtles) and non-aquatic taxa between TBDP and BW data (n=2210). All comparisons exhibited significantly different faunal abundances ( $\chi^2 > 37$ , df.=1, p<0.001), except for the Okote Member in the Karari Ridge subregion. Aquatic fauna were systematically underrepresented in the TBDP. Second, we compared the abundances of seven common mammalian families in analytical subsets of the TBDP corresponding to craniodental versus postcranial fossils (n=8674). A chi-square test revealed significant differences in familial abundance ( $\chi^2 = 1332.8$ , df.=6, p=.0001). In the postcranial dataset, Suidae, Bovidae, and Elephantidae were underrepresented while Hippopotamidae and Cercopithecidae were overrepresented.

These results illustrate that collection strategies can impact paleoenvironmental reconstructions based on faunal abundance, which could affect the inferences associated with environmental hypotheses of human evolution.

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### Facial fluctuating asymmetry in wild Virunga mountain gorillas (*Gorilla beringei beringei*)

AMANDINE B. ERIKSEN<sup>1</sup>, KATE MCGRATH<sup>2</sup>, AIDA GÓMEZ-ROBLES<sup>3</sup>, LAUREN SCHROEDER<sup>1</sup>, JASON S. MASSEY<sup>3</sup>, TIMOTHY G. BROMAGE<sup>4</sup>, ANTOINE MUDAKIKWA<sup>5</sup>, TARA S. STOINSKI<sup>6</sup>, MICHAEL R. CRANFIELD<sup>7</sup>, MATTHEW W. TOCHER<sup>8,9</sup>,

SHANNON C. MCFARLIN<sup>10,2</sup> and NOREEN VON CRAMON-TAUBADEL<sup>1</sup>

<sup>1</sup>Buffalo Human Evolutionary Morphology Laboratory, Department of Anthropology, University at Buffalo, <sup>2</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>3</sup>Department of Anthropology, University of Minnesota, <sup>4</sup>Department of Biomaterials and Biomimetics, New York University College of Dentistry, <sup>5</sup>Department of Tourism and Conservation, Rwanda Development Board, <sup>6</sup>Dian Fossey Gorilla Fund International, Atlanta, Georgia, <sup>7</sup>Mountain Gorilla Veterinary Project, University of California, Davis, <sup>8</sup>Department of Anthropology, Lakehead University, <sup>9</sup>Human Origins Program, National Museum of Natural History, Smithsonian Institution, <sup>10</sup>Division of Mammals, National Museum of Natural History, Smithsonian Institution

The study of facial asymmetry offers valuable insight into extrinsic (environmental) and intrinsic (genetic) factors influencing early development. Random deviations from bilateral symmetry can be quantified as directional and fluctuating asymmetry (DA and FA). While DA is commonly assumed to reflect genetic factors, FA is used to study developmental instability. The Virunga mountain gorillas provide an excellent case-study for assessing the link between FA and developmental stress, given the availability of long-term life history data coupled with the high degree of cranial asymmetry observed in the skeletons of these critically endangered apes. To assess FA among mountain gorillas, 3D models of 71 crania (37 female, 34 male), curated by Rwanda's Mountain Gorilla Skeletal Project and the Smithsonian's National Museum of Natural History, were acquired using laser and CT scanning. Thirty facial landmarks were digitized from each 3D model, followed by an assessment of inter- and intra-observer error. A Procrustes ANOVA was conducted in MorphoJ, and individual FA scores were calculated. Results suggest that FA is a significant contributor to overall facial shape variation. A chi-squared analysis found that females were more likely to exhibit higher FA scores than males, which may relate to particular stress factors impacting female development. This study offers the first quantification of FA in mountain gorillas, suggesting that FA may prove a useful proxy for measuring the effects of developmental stress in wild primates. Future work incorporating long-term behavioral and health data will further test how early life stress manifests itself in gorillas via facial asymmetry.

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### The Statistics of Tiny Samples: The Utility of ACTUS, an Alternative Method of Contingency Table Analysis Using Simulation, in Human Skeletal Biology

VIRGINIA H. ESTABROOK<sup>1</sup> and DAVID A. PROSSER<sup>2</sup>

<sup>1</sup>Department of Criminal Justice, Social and Political Science, Armstrong State University, <sup>2</sup>School of Criminal Justice, Texas State University

Contingency table analyses of count data can be incredibly useful for the inference of relationships between variables and proportional differences between skeletal populations. Of the most frequently used methods for making these inferences, the chi-square test cannot be applied to small samples and Fisher's Exact test cannot be applied to tables larger than 2x2. Consequently, many bioarchaeological and paleopathological studies involving few instances of the variable of interest rely on sample proportions to draw conclusions about population proportions. An alternative approach to these methods of analysis is ACTUS (Analysis of Contingency Tables Using Simulation), a computationally intense simulation program developed by George Estabrook and used mainly in biology. Compared to traditional methods, ACTUS offers four advantages: it enables rigorous statistical inferences despite low counts; it generates probability values for each individual cell, aiding interpretation of probability values generated for the entire table; even the least quantitatively oriented anthropologist can understand how the program works; and the free software operates rapidly, producing results based on thousands of simulated tables in seconds. We explain the methodology of how ACTUS works and use several examples related to incidence of traumatic injuries and other pathologies to demonstrate its utility for comparative analyses.

### Behavioral traces on dental wear in Pleistocene fossil humans

ALMUDENA ESTALLRRICH<sup>1,2</sup>, MARINA LOZANO<sup>3,4</sup>, LUCA BONDIOLI<sup>5</sup>, IVANA FIORE<sup>5</sup>, JOSÉ MARÍA BERMÚDEZ DE CASTRO<sup>6,7</sup>, JUAN-LUIS ARSUAGA<sup>8,9</sup>, EUDAL CARBONELL<sup>3,4</sup>, ANTONIO ROSAS<sup>1</sup>, OTTMAR KULLMER<sup>2</sup> and DAVID FRAYER<sup>10</sup>

<sup>1</sup>Paleobiology, Paleoanthropology Group, Museo Nacional de Ciencias Naturales-CSIC, Spain, <sup>2</sup>Department of Palaeoanthropology, Senckenberg Research Institute Frankfurt, Germany, <sup>3</sup>IPHES, Institut Català de Paleoecologia Humana i Evolució Social, Tarragona, Spain, <sup>4</sup>Area de Prehistoria, Universitat Rovira i Virgili (URV), Tarragona, Spain, <sup>5</sup>Sezione di Antropologia, Museo Nazionale Preistorico Etnografico "L. Pigorini" Rome, Italy, <sup>6</sup>CENIEH, Centro Nacional de Investigación sobre Evolución Humana, Burgos, Spain, <sup>7</sup>Anthropology, UCL, London, UK, <sup>8</sup>Evolución y Comportamiento Humanos, Centro Mixto UCM-ISCIII, Madrid, Spain, <sup>9</sup>Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Madrid, Spain, <sup>10</sup>Department of Anthropology, University of Kansas, USA

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Following the emergence of the *Hominini*, the biological evolution of the tribe has been always accompanied by cultural changes, and behavioral patterns were underlying the relationships among individuals. These behavioral patterns allowed and helped the first humans to adapt, spread, and evolve into who we are today. This study aims to analyze non-masticatory dental wear patterns in fossil *Homo* in order to trace the expression of some behavioral patterns and cultural habits among these species.

The sample studied includes early *Homo*, Middle Pleistocene *Homo* (Atapuerca-SH) and *H. neanderthalensis* (Sidrón, Cova Foradà, Valdegoba, Krapina, Vindija among other). Original teeth and high-resolution replicas were analyzed using Scanning Electron Microscopy. The recorded non-masticatory dental wear features indicate an increase of the use of the mouth in non-masticatory tasks from early *Homo* (cultural striations 1.8 Mya, and toothpicking) during the Pleistocene, with the highest incidence and variety of dental wear features detected (cultural striations, toothpicking, dental chipping, parafacets) in *Homo neanderthalensis*, as well of some evidence of sex-related differences.

The increase in the use of the dentition in non-masticatory activities could be related to the development of the behavioral complexity during the Pleistocene. In this sense, the increasing number of cultural striations could be interpreted as the diversification of the activities that use the mouth as a third hand such as skins and vegetable fibers preparation for clothing and other crafts. On the other hand, the generalization of toothpicking and dental chipping could be associated with the spread of oral hygiene or therapeutic habits.

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### Community Support Buffers Psychosocial Stress in Mothers of Infants

BRANDICE N. EVANS and BETHANY L. TURNER  
Anthropology, Georgia State University

A substantial corpus of research has identified infancy as a key period in human development that shapes health outcomes throughout the life course. The effects of maternal stress on infant health and well-being has also been studied, but less is understood about the effects of maternal stress on mothers' abilities to breastfeed their babies, which is a critical factor mediating infant and child health. This study therefore assesses psychosocial stress in mothers of children under two years of age in relation to socioeconomic factors such as income, childcare access, extended family support, peer support, and nutritional and lactation education received from

health providers among mothers of children to gain a better understanding of what factors buffer maternal stress. Participants also completed the Perceived Stress Scale (PSS), and hair samples were collected and assayed for cortisol concentration from each participant. Preliminary results indicate that women who reported participating in community peer support groups have lower cortisol levels, as well as PSS scores and had higher rates of breastfeeding initiation and duration. Women who reported recent stresses which resulted in the decrease or loss of support systems, such as relocating or returning to work abruptly, have higher concentrations of cortisol as well as higher scores on the PSS in comparison. These findings suggest that maternal cortisol production is largely tied to maternal peer support during the first two years postpartum, and that social support acts as an important buffering system against psychosocial stress.

### A new reconstruction of the Sts 14 pelvis supports a human-like birth mechanism in *Australopithecus africanus*

JENNIFER EYRE<sup>1,2</sup> and SCOTT A. WILLIAMS<sup>1,2</sup>

<sup>1</sup>Anthropology, Center for the Study of Human Origins, New York University, <sup>2</sup>Anthropology, New York Consortium in Evolutionary Primatology

Modern humans experience rotational birth, and the size of the neonatal head and shoulders closely fits the maternal birth canal. It is unclear when this form of birth evolved. Fossils such as Sts 14—a partial *Australopithecus africanus* pelvis—can shed light on this issue, but it is incomplete and partly deformed. Sts 14 has been reconstructed manually and digitally by different researchers using different methods. Since each reconstruction is a hypothesis, new methods can be used to test previous reconstructions and help narrow down the range of possible pelvic morphologies, which in turn affects the interpretation of the mechanism of birth in *A. africanus*.

Here, we reconstruct Sts 14 using 3D surface models of the original fossils. Complete, undistorted portions on the left side were mirror-imaged across the sagittal midplane to fill in missing portions on the right. The auricular surfaces of the sacrum and ilium were aligned by matching landmarks on the two surfaces. The pubis was recreated using an expectation maximization algorithm utilizing a sample of modern human females. Measurements were taken and compared to those reported from a reconstruction by Berge and Goullaras (2010) and differed by less than 6%. Therefore, their conclusion that the mechanism of birth was human-like in Sts14, is supported in our study. A.L. 288-1 (*Australopithecus afarensis*) and MH2 (*Australopithecus sediba*) pelvises were also reconstructed using these methods in order to explore pelvic morphology within the australopithecine clade.

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### The Bioanthropology of the inhabitants of the Late Middle to Early Late Bronze Age at Megiddo, southern Levant

MARINA FAERMAN<sup>1</sup>, MARIO MARTIN<sup>2</sup> and PATRICIA SMITH<sup>3</sup>

<sup>1</sup>Laboratory of Bioanthropology and Ancient DNA, The Hebrew University Of Jerusalem, <sup>2</sup>Institute of Archaeology, Tel Aviv University, <sup>3</sup>Laboratory of Bioanthropology and Ancient DNA, The Hebrew University Of Jerusalem

We analyzed the human remains recovered from individual and multiple burials (chamber-tomb, pits, jars, pithoi) excavated in Area K at Megiddo in 2010–2014 and associated with the MB III–LB I period. Fifteen intra-mural burials were found in close proximity to the chamber-tomb, which yielded the remains of 23 individuals. The age distribution differed between that of the chamber-tomb and intra-mural burials. The combined sample included 44 individuals of all age groups (24% infants, 38% children and adolescents, and 38% adults) and both sexes (7' and 9'). Morphological features and stature estimates (169 and 154 cm in males and females, respectively) fall well within the range of known MB II–LB I Levantine populations. The high infant mortality, together with dental enamel hypoplasia and skeletal pathology, the latter including lesions indicative of scurvy, suggests that health status was poor and that the people of Megiddo suffered from multiple environmental stress events caused by dietary deficiencies and infections. High frequency of calculus (87.5% of individuals) and ante-mortem tooth loss (83.3% of individuals) point to a sticky diet, rich in carbohydrates. The significance of these findings will be discussed through intra- and inter-site comparisons of contemporaneous populations in the southern Levant.

### Bone deep: stable nitrogen isotope ratios and histomorphometric measurements of bone remodelling within adult human skeletons

GERALDINE E. FAHY, CHRIS A. DETER, ROSIE PITFIELD and PATRICK MAHONEY

Human Osteology Lab, Skeletal Biology Research Centre, School of Anthropology & Conservation, University of Kent

This pilot study investigates variation in bone turnover rates (BTR) between different bone types to better understand sampling methods for stable isotope analysis of human bone. Currently, standard stable isotope sampling involves rib or femoral bone to infer aspects of past diets and lifestyles, yet it is unknown if isotopic results vary between different bone types, and if so, by how much. To date, it is unknown how bone

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remodeling may affect isotopic results. It is known that bone constantly remodels throughout an individual's lifetime and BTR will vary depending upon age, biological sex and health. Bones with different densities also have a different BTR. Based upon these differences we hypothesized that bones with different BTR's from the same person would produce different isotopic results. We analyzed  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ , and calculated mean osteon population density and the density of osteocyte lacunae for ten different bones from ten adult skeletons ( $n=5\text{M}$ ;  $n=5\text{F}$ ).  $\delta^{13}\text{C}$  values varied within normal  $\text{C}_3$  dietary ranges. However,  $\delta^{15}\text{N}$  ratios varied between 0.98 to 3.05‰ within each skeleton. Ribs, metacarpals, and humerus had the highest rate of bone turnover, the clavicle and occipital had the lowest. Within each skeleton, bones with higher turnover rates were generally depleted in  $\delta^{15}\text{N}$ . Our findings illustrate the need to standardize bone sampling in stable isotope studies of diet to bones with either high or low turnover.

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### The applicability of dental wear in age estimation for a modern American population

KATIE E. FAILLACE<sup>1</sup>, JONATHAN D. BETHARD<sup>2</sup> and MURRAY K. MARKS<sup>3</sup>

<sup>1</sup>Department of Anatomy and Neurobiology, Boston University, <sup>2</sup>Department of Anthropology, University of South Florida, <sup>3</sup>Department of Pathology, University of Tennessee

Though widely applied in bioarchaeology, dental wear has been underexplored as an age indicator in the biological anthropology of contemporary peoples, although research has been conducted on dental attrition in forensic contexts (Kim et al. 2000, Prince et al 2008, Yun et al 2007). This study examined the hypothesis that methods for age estimation based on dental wear can be adapted for a modern American population and produce accurate and useful age-range estimates for individuals in 21<sup>st</sup>-century contexts. If correct, dental attrition may be easier to apply than other age estimation methods due to the survivability of teeth, ease of ordinal scoring systems, and non-destructive nature. Methodologies following Yun et al. (2007) and Prince et al. (2008) were applied to a random sample of 583 individuals from the University of New Mexico Documented Skeletal Collection and Economides Orthodontic Cast Collection. Pearson correlations of tooth wear score and age were significant ( $p<0.001$ ) for all teeth and multiple linear regression demonstrated that 50% of age estimates fell within +/-10 years of the actual age. However, comparable to many other age estimation techniques, accuracy improved for the younger age group (<45 years), with 74% of predictions within +/-10 years. This study demonstrates that there is a broadly predictive relationship between wear and age in modern

Americans; this relationship merits further exploration into the impact of other cultural factors on dental wear and the impact of biological age within current American society.

### Bacterial Succession in Bone Marrow as a Potential Tool for Estimating PMI

CHRISTIANA T. FAKHRI, LAURA SPOONIRE and NICHOLE RUBLE

Biological Sciences, Sam Houston State University

Postmortem interval (PMI), an estimate of time since death, is traditionally determined using soft tissues and based on stages of decay, insect activity, and bacterial progression. Due to variables such as season, moisture, and climate, PMI estimates reliant on soft tissue methods remain inexact. Such methods are further limited by relatively quick decay of soft tissues, typically days or weeks. However, the environment inside of marrow-containing bones may provide a more controlled environment relevant to PMI. Bone persists for weeks or months, potentially extending the range of PMI estimation. Here we test for variation in the composition and progression of bacterial communities in pelvic, femoral, and humeral bone marrow from three human cadavers (two males, one female). For four months, we sampled left elements every other day and right elements every tenth day (as a control for introduced contamination). Field research took place at the Southeast Texas Applied Forensic Science (STAFS) facility at Sam Houston State University beginning in May, 2016. We sterilized sampling locations and collection tools in order to limit contamination. Samples were collected using a T-Lok Bone Marrow Biopsy Needle and stored in cryotubes for deep sequencing of the 16S RNA gene using PCR amplification and illumina protocols at Baylor College of Medicine. Preliminary results suggest that bone marrow biomes are consistent across element and cadaver, and therefore potentially useful for determining a more accurate PMI. We expect that this method of PMI estimation will ultimately provide a more accurate tool in forensic sciences.

### Number of battle deaths scale with population size rather than differential proclivities for violence among humans living in nonstate and state societies

DEAN FALK<sup>1,2</sup> and CHARLES HILDEBOLT<sup>3</sup>

<sup>1</sup>Anthropology, Florida State University, <sup>2</sup>Scholars Program, School for Advanced Research, <sup>3</sup>Radiology, Washington University School of Medicine

In his book, *The Better Angels of Our Nature*, Steven Pinker compared annual war deaths per 100,000 individuals in 27 nonstate and nine state societies, which led him to conclude that states are far less violent than traditional small-scale societies. Because these data were

opaque regarding absolute population sizes, we collected data for mean annual deaths caused by aggressors from external communities and absolute population sizes from the literature for 11 chimpanzee communities, 24 nonstates (18 listed by Pinker), 20 countries that fought in WWI and 22 countries from WWII. For chimpanzees, a Cochran-Armitage trend test indicated that as mean community population size increased, the ratio of mean annual deaths from external aggressors to population size decreased ( $p=0.0250$ ), consistent with the adage "there is safety in numbers." The chimpanzee equivalent to human annual relative warfare death rates, thus, measured their relative *vulnerability* to lethal intercommunity violence rather than their relative proclivity for violence. Cochran-Armitage trend tests for nonstates, WWI, and WWII show that as mean population sizes increased, mean annual battle deaths expressed as percentages of population size decreased at highly significant levels ( $p=0.0001$ ), similar to the trend for chimpanzees. Reduced major axis regression analyses showed that absolute number of annual battle deaths increased ( $p<0.0088$ ) with population size for humans in small-scale and state societies, but there was no comparable relationship among chimpanzees ( $p=0.5706$ ). We conclude that war deaths sustained by humans scale with population size rather than differential proclivities for violence in different types of society, contrary to Pinker.

### Temporal trends in medieval diet at Stoke Quay, Ipswich, England

ELEANOR FARBER<sup>1</sup>, ALICE ROSE<sup>2,3</sup>, JULIA LEE-THORP<sup>1</sup>, LOUISE LOE<sup>3</sup> and HELENA HAMEROW<sup>4</sup>

<sup>1</sup>Research Laboratory for Archaeology and the History of Art, University of Oxford, <sup>2</sup>Department of Archaeology, Cambridge University, <sup>3</sup>Burials Department, Oxford Archaeology, <sup>4</sup>Institute of Archaeology, University of Oxford

Isotopic studies focusing on medieval York, London, Southampton and Norwich have suggested an increase in marine resource consumption in England after the 11<sup>th</sup> century, but until now, no major studies have been conducted on Ipswich, the largest trade center in medieval Suffolk. Recent excavations at Stoke Quay, Ipswich produced a large collection of burials that can improve our understanding of medieval diet at this important site. Comprising 20 individuals from a 6<sup>th</sup>-8<sup>th</sup> century AD Saxon burial landscape and 1,142 individuals from a 9<sup>th</sup>-15<sup>th</sup> century AD cemetery, it is an exceptional assemblage in terms of its continuous chronological sequence and because it is one of the largest medieval assemblages in England. As such, the Stoke Quay collection provides a rare opportunity to conduct detailed dietary studies at a single site over hundreds of years.

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Here, we present results from a pilot study on temporal trends in medieval diet at Stoke Quay. We analyzed stable carbon and nitrogen isotopes from the bone collagen of 48 individuals from the site's cemetery and 2 individuals from its Saxon period. Our  $\delta^{15}\text{N}$  results span from 8.9‰ to 14.9‰ (mean: 12.6‰  $\pm$  1.3), with a  $\delta^{13}\text{C}$  range from -20.2‰ to -17.4‰ (mean: -18.8‰  $\pm$  0.7). We observe a statistically significant enrichment in  $\delta^{13}\text{C}$  values from the earliest to latest periods but a great deal of variation in both isotopic systems over time, indicating that increased marine resource consumption may have begun earlier and more gradually at Ipswich than at contemporary English sites.

### Neonatal hair cortisol in rural Gambian infants

SARA FARDI<sup>1</sup>, SAIKOU DRAMMEH<sup>2</sup>, ANDREW DOEL<sup>2</sup>, ANDREW M. PRENTICE<sup>2</sup>, SOPHIE E. MOORE<sup>2,3</sup> and ROBIN M. BERNSTEIN<sup>1,4</sup>

<sup>1</sup>Anthropology, University of Colorado Boulder, <sup>2</sup>The Gambia, MRC Unit, <sup>3</sup>Division of Women's Health, Kings College London, <sup>4</sup>Institute of Behavioral Science, University of Colorado Boulder

Physical workload, food availability, and disease burden vary seasonally in rural Gambia. Season of conception and birth are significantly associated with epigenetic modifications, patterns of growth, and mortality. During pregnancy, seasonal stressors could affect the enzymatic barrier that buffers the developing fetus from circulating maternal cortisol, with potential negative effects on growth. We used neonatal hair samples collected from infants at their naming ceremony on Day 7 of life, and thus grown during gestation, as a proxy measure of average fetal cortisol concentrations. Hair samples (N=203) were ground, incubated in methanol and dried down under a stream of nitrogen gas. Cortisol was measured using commercially available kits developed for use in saliva and previously validated for use in hair (Salimetrics, PA). We used mixed models to assess the relative contributions of infant, maternal, and environmental factors to variation in hair cortisol, and the relationship of hair cortisol to infant size. Gestational age ( $p < 0.001$ ; later gestational age = higher) and birth weight ( $p < 0.05$ ; heavier infants = lower), predicted hair cortisol in our sample, consistent with results from other populations. Perhaps surprisingly, maternal factors and season of birth or conception did not predict neonatal hair cortisol; similarly, neonatal hair cortisol does not correlate with psychological stress in mothers in the United States. This suggests that maternal buffering systems are robust in the face of various stressors, and/or that a different measure may be needed to accurately capture how maternal and environmental stress may be signaled to the developing fetus.

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### The Bioarchaeology Field and the Study of Ancient Egypt - Development and Characteristics of Academic Publications

LUÍSA B. FARIA

Departamento de Antropologia, Universidade Federal do Rio de Janeiro

Bioarchaeology has been changing and developing since its beginning in the second half of the 20th century. In Egypt, the bioarchaeological research has its own reality compared to the study of other places and periods. The duality between the great number of preserved ancient human remains and the academic focus on scriptures and non-biological materials on Ancient Egypt study is the main reason to the very particular reality in this area. The present paper will map the trajectory of this field in the study of Ancient Egypt through the analysis of published papers in order to identify the development, trends, difficulties and possible solutions within the area.

The analysis of papers on Bioarchaeology from the American Journal of Physical Anthropology shows a significant growth on publications since the 1990's, two decades after the beginning of this field. It is around this period that bioarchaeological research became more expressive in Egypt. In the last decades, Egypt has witness the appearance of Bioarchaeological field school and field work along with the growth of publications. It is also interesting to notice that the majority of the researchers are from the USA or Europe and it is really difficult to find Egyptians working in this area. The field still needs to catch up with the Bioarchaeology practiced in the rest of the world and an effective way of encourage its development is giving more space to bioarchaeological work in Egypt.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Capes

### An Analysis of Shape Differences in Crocodylian Dentition Using Geometric Morphometrics

PAUL FARRUGIA, JACKSON K. NJAU and P. DAVID POLLY

Geological Sciences, Indiana University

Many African paleoanthropological sites yield crocodylian teeth found in association with hominin trace fossils, typically in wetland environments. Crocodiles were among the largest predators on the landscape, posing a serious threat to hominins, yet we know little about their body sizes. This is because their teeth, used mainly as indicators of aquatic habitats and for taphonomic and taxonomic assessment, are

otherwise neglected. However, slight differences in tooth shape can be used to estimate the position within the jaw, and along with tooth size can be used to estimate body size. Most research acknowledge variations in tooth shape, but this problem has not been addressed quantitatively. This study explores shape variation in the outlines of crocodylian teeth, as they relate to position within the jaw, using two-dimensional geometric morphometrics. Outlines consisting of 100 landmarks and semi-landmarks were collected from the buccolabial surfaces of tooth crowns from *Crocodylus niloticus*, Procrustes superimposed, and subjected to a principle components analysis. PC1 accounted for 86% of shape variance. An anterior-posterior shape gradient was constructed using a multivariate regression of tooth shape onto position. Results show that there is a correlation between PC1 (shape) and position ( $R^2 = 0.64$ ,  $p < 0.01$ ). ANOVA test showed significant differences in tooth shape between positions ( $p < 0.05$ ). There is a clear difference between the shapes of anterior versus posterior teeth, with a gradual transition between the two. Further research will use these results to build a model for predicting body size from Pleistocene crocodile teeth recovered from the DK site, Olduvai Gorge.

### Ontogeny of Morphological Variation in the Talar Trochlea of Gorilla

LAWRENCE M. FATICA<sup>1</sup>, KEVIN TURLEY<sup>2</sup>, ANTOINE MUDAKIKWA<sup>3</sup>, MICHAEL R. CRANFIELD<sup>4</sup>, TARA S. STOINSKI<sup>5</sup>, SHANNON C. MCFARLIN<sup>1,6</sup> and SERGIO ALMÉCJA<sup>1,7</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, Washington DC, U.S.A., <sup>2</sup>Department of Anthropology, University of Oregon, Eugene, Oregon, U.S.A., <sup>3</sup>Department of Tourism and Conservation, Rwanda Development Board, Kigali, Rwanda, <sup>4</sup>Mountain Gorilla Veterinary Project & Baltimore Zoo, Baltimore, MD, U.S.A., <sup>5</sup>Dian Fossey Gorilla Fund International & Zoo Atlanta, Atlanta GA, U.S.A., <sup>6</sup>Division of Mammals, National Museum of Natural History, Smithsonian Institution, Washington DC, U.S.A., <sup>7</sup>Institut Català de Paleontologia Miquel Crusafont (ICP), Cerdanyola del Vallès, Barcelona, Spain

Previous researchers have described a morphocline in the talar morphology of subspecies of *Gorilla* in which the topography of the talar trochlea of more arboreal populations (*Gorilla gorilla gorilla*, lowland populations of *Gorilla beringei graueri*) reflected a more medially directed sole of the foot compared to more terrestrial populations (*Gorilla beringei beringei*, highland populations of *G. b. graueri*). It remains unclear, however, whether these differences are due to genetic differences between populations or a plastic response to differences in locomotor behavior. Knowledge of the factors that contribute to talar trochlea morphology can

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inform interpretations of talar variation in the fossil record.

Here, we use 3D geometric morphometrics and trajectory analysis in shape space to characterize the morphology of the talar trochlea through ontogeny in *G. g. gorilla* and *G. b. beringei*. Shape differences were apparent early in ontogeny, well before adult morphology is attained. Further, trajectory analysis of the two subspecies through developmental time found that their trajectories are distinct only in the overall magnitude of shape change, but not in their overall shape or direction through shape space. This suggests that differences observed among adults of the studied populations are primarily due to differences in initial shape, while similar developmental processes underlie their maturation to adult morphology. This finding lends support to the hypothesis that genetic differences rather than phenotypic plasticity is responsible for the differences observed in adult trochlear morphology. Future work will compare populations of the same subspecies from different habitats to better control for species-levels differences.

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### Exploring the mode and tempo of Madagascar's lemuriform radiation

SARAH FEDERMAN<sup>1</sup>, GREGG GUNNEL<sup>3</sup>, ROSLYN RIVAS<sup>1</sup>, ERIC SARGIS<sup>4</sup>, ANNE YODER<sup>3</sup>, GEORGE PERRY<sup>5</sup> and ALEX DORNBURG<sup>2</sup>

<sup>1</sup>EEB, Yale University, <sup>2</sup>North Carolina Museum of Natural Sciences, North Carolina Museum of Natural Sciences, <sup>3</sup>Duke Primate Center, Duke, <sup>4</sup>Anthropology, Yale University, <sup>5</sup>Anthropology, Pennsylvania State University

Lemurs are perhaps the most well-known of Madagascar's endemic radiations. This emblematic clade has given rise to a staggering diversity of ecologies, morphologies and life-history strategies that have evolved since lemurs reached the island over 60 million years ago. However, while lemurs have been the subject of much research, we still know relatively little about the mode and tempo of this radiation, inferences made especially difficult given the dearth of Malagasy fossils from the Cenozoic. What is the nature of morphological and ecological diversification dynamics in lemurs? Is increased disparity among taxa linked to climatic transitions and the development of novel vegetative zones on the island? Although numerous studies suggest a single early burst of diversification in lemurs, recent studies have raised the possibility of multiple adaptive peaks that could correlate with different ecological transitions. We employ multiple lines of evidence that integrate morphological, climatic, biogeographic, ecological, and phylogenetic data to explore the

evolutionary dynamics of the lemuriform radiation in Madagascar. Our analyses support a series of relatively recent bursts of morphological and ecological disparity corresponding with the establishment of Madagascar's wet-forest biome, which contains the majority of contemporary Malagasy diversity. This signature is lost when recently extinct taxa are excluded from the analyses, underscoring the importance of considering historical contingencies and incorporating multiple lines of evidence into phylogenetic inference.

### Paleogenomic investigations of human remains from Rapa Nui

LARS FEHREN-SCHMITZ<sup>1</sup>, KELLY M. HARKINS<sup>1</sup> and CATRINE L. JARMAN<sup>2</sup>

<sup>1</sup>UCSC Paleogenomics Lab / Anthropology, University of California, Santa Cruz, <sup>2</sup>Department of Archaeology and Anthropology, University of Bristol

Since Easter Sunday of 1722, when Jacob Roggeveen became the first western seafarer to reach Rapa Nui, this remote island in the Eastern Pacific has inspired fiction and science regarding the origin and life of its inhabitants. While the Polynesian ancestry of the first settlers is widely accepted, other events in the population history of the people of Rapa Nui, especially contact with South America, remain controversial. Although researchers recently found signals of Native American admixture when analyzing modern ancestors of indigenous inhabitants of Rapa Nui – suggesting genetic contributions from South America prior to the European contact – there is still considerable doubt regarding the timing of that admixture event, or the directionality and origin of the trans-Pacific contact. Here we present the results of our paleogenomic investigations of seven samples excavated from Ahu Nau Nau, Anakena, by the Kon-Tiki Museum, dating to periods of pre- and post-European contact. Despite the challenging preservation and small material quantity of these rib samples, we were able to obtain complete mitochondrial genomes and low coverage genome-wide sequence data from four samples using a combination of shotgun sequencing and a novel whole genome enrichment assay. We combine the data with ancient and contemporary Native American, Oceanian, and global population data to find that the analyzed individuals fall well into the genetic diversity of Polynesian populations. We find no admixture with Europeans in the post-contact samples with an increased Melanesian component, while an admixture with Native Americans remains inconclusive.

### Dual Rank Attainment Strategies by Male Chimpanzees in Gombe National Park, Tanzania

JOSEPH T. FELDBLUM<sup>1</sup>, EMILY E. WROBLEWSKI<sup>2</sup>, REBECCA S. RUDICELL<sup>3,4</sup>, YINGYING LI<sup>5</sup>, BEATRICE H. HAHN<sup>5</sup>, CHRISTOPHER KRUPENYE<sup>6</sup>, ANNE E. PUSEY<sup>1</sup> and IAN C. GILBY<sup>7</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Structural Biology, Stanford University School of Medicine, <sup>3</sup>Vaccine Research Center, National Institutes of Health, <sup>4</sup>Sanofi, Sanofi, <sup>5</sup>Medicine and Microbiology, Perelman School of Medicine, University of Pennsylvania, <sup>6</sup>Max Planck Institute for Evolutionary Anthropology, Max Planck Institute for Evolutionary Anthropology, <sup>7</sup>School of Human Evolution and Social Change, and Institute of Human Origins, Arizona State University

While the adaptive value of social bonds is well demonstrated in female non-human primates, the relationship between social bonds and fitness in males is newly emerging. In male macaques and chimpanzees, aggressive coalition formation was associated with rank increase and reproductive success. However, in chimpanzees coalitions are relatively rare, and the relative influence of coalitionary aggression and social bonds on fitness remains uncertain. Here, we investigate whether social bonds and coalitionary aggression predict rank change in one community of wild chimpanzees. We calculated individual network centrality measures from grooming, association, and coalitionary aggression data, in two-year periods between 1994 and 2011. We employed multimodel inference with AICc as the selection criterion to determine the best of these measures for predicting rank change (both as change in Elo score and as a binary measure indicating rise into the top three rank positions). In predicting continuous rank change, grooming others and being groomed were associated with opposite changes in rank, while coalition formation was not important. In predicting rise into the top three positions, coalitionary betweenness was positively associated with rank increase, while grooming was not important. Thus, different strategies may benefit males in rank acquisition at different points in the hierarchy: strategic allocation of grooming is associated with rank increase for most males, but those males who rise to the very top tend to be central figures in the politics of coalitionary aggression. Future work with an expanded dataset will investigate the surprising relationship between in-grooming, out-grooming, and rank change.

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## ABSTRACTS

### Molar Size and Shape Variation in a Large Sample of *Niptomomys* (Microsypidae, Primates) from the Paleocene-Eocene Thermal Maximum: One Species or Two?

ROSA S. FELIBERT<sup>1</sup>, PAUL E. MORSE<sup>1,2</sup>, SUZANNE G. STRAIT<sup>3</sup>, DOUG M. BOYER<sup>4</sup> and JONATHAN I. BLOCH<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>Florida Museum of Natural History, University of Florida, <sup>3</sup>Department of Biological Sciences, Marshall University, <sup>4</sup>Department of Evolutionary Anthropology, Duke University

The oldest euprimates first appear during a period of rapid, short-term, global warming ~56 mya known as the Paleocene-Eocene Thermal Maximum (PETM). Plesiadapiform primates of similar size and dental morphology to euprimates were present in North America before the PETM, and may have been affected by the arrival of euprimates as ecological competitors. Screenwashing PETM fossil localities in the Bighorn Basin, Wyoming, has yielded many fossils (N=600) of the microsypid plesiadapiform *Niptomomys*. *N. doreanae* is known from before and after the PETM and may range through it. A second taxon, *N. favorum*, characterized by its small size and squarer M<sup>2</sup> occlusal outline, was described from the large Castle Gardens locality sample. To better characterize PETM primate diversity, we test the validity of *N. favorum* against a sample of *Niptomomys* from Castle Gardens, other PETM localities, and published measurements. M<sup>2</sup> occlusal outlines (N=66) revealed a continuous range from square to lingually compressed that encompasses the holotype of *N. favorum*. Linear measurements of M<sub>1</sub> (N=45) and M<sub>2</sub> (N=55) indicated M<sub>1</sub>'s from Castle Gardens are larger than those of later PETM localities ( $p=0.038$ ), but produced no outliers, suggesting the PETM fauna contains one species of *Niptomomys*. PETM lower molars are smaller than all other measured *Niptomomys* teeth, paralleling the response to warming effects recorded in larger-bodied mammal lineages. These results are consistent with either a single lineage of *Niptomomys* that became smaller during the PETM, or a small immigrant taxon (*N. favorum*) that was transitionally present in the Bighorn Basin during the PETM.

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### New Insights on the *Homo naledi* Ankle Using Three-dimensional Quantification

AILEEN FERNANDEZ<sup>1</sup> and WILLIAM E.H. HARCOURT-SMITH<sup>2,3,4,5</sup>

<sup>1</sup>Department of Anthropology, University of Oregon, <sup>2</sup>Department of Anthropology, Lehman College CUNY, <sup>3</sup>Division of Paleontology, American Museum of Natural History, <sup>4</sup>Department of Anthropology, Graduate Center CUNY, <sup>5</sup>NYCEP, New York Consortium in Evolutionary Primatology

Investigating talar morphological variation is central to better understanding potential differences in fossil hominin ankle function. In particular, the angular relationships between the talar articular facets are thought to relate to numerous aspects of ankle and foot function, from inversion/eversion ranges to longitudinal arch height. In this study we assess these angular relationships within extant hominoids and fossil hominin tali, including newly described material attribute to *H. naledi*. Our sample consists of 145 adult tali from *H. sapiens*, *Gorilla*, *P. troglodytes*, *Pongo* and a range of East and South African fossil hominins. Six different angular measurements between paired facets were quantified using laser scans and best-fit planes that utilize a curvature-fitting algorithm in Geomagic Control software. Data were analyzed using PAST. Results show that the angle between the trochlea and navicular facet strongly differentiate all taxa, while those between the trochlea and medial malleolus and posterior calcaneal facet respectively separate *H. sapiens* from all other extant taxa. All other angular relationships are uninformative. A Principal Component Analysis of all variables clearly separates *H. sapiens* from extant great apes. The tali of *Homo naledi*, alongside *Au. sediba* and those from Koobi Fora, Kenya, fall outside the human range and within that of extant great apes, while *Au. afarensis* is intermediate. The Omo (323-76-898) talus is the only specimen to fall within the modern human range. This novel finding indicates that, with respect to talar articular facet angular relationships, *H. naledi* likely had an ankle unlike that of modern humans.

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### Functional Morphology and Evolution of the Early Hominin Forefoot

PETER J. FERNÁNDEZ<sup>1</sup>, CARRIE S. MONGLE<sup>2</sup>, BIREN A. PATEL<sup>3,4</sup>, MATTHEW W. TOCHER<sup>5,6</sup> and WILLIAM L. JUNGERS<sup>7</sup>

<sup>1</sup>Anatomical Sciences, Stony Brook University, <sup>2</sup>IDPAS, Stony Brook University, <sup>3</sup>Cell and Neurobiology, University of Southern California, <sup>4</sup>Human and Evolutionary Biology, University of Southern California, <sup>5</sup>Anthropology, Lakehead University, <sup>6</sup>Human Origins Program, Smithsonian Institution, <sup>7</sup>Research Associate, Association Vahatra

During bipedal walking, modern humans dorsiflex their forefoot at the metatarsophalangeal joints (MTPJs) as part of the push off phase of gait, which tightens plantar soft tissues to convert the foot into a stiff, propulsive lever. Features of metatarsal head morphology such as "dorsal doming" are thought to facilitate this stiffening mechanism. Comparative studies between humans and chimpanzees have shown that dorsal doming is significantly correlated with *in vivo* range of motion at the MTPJs, with the

former showing greater doming and a greater range of MTPJ dorsiflexion during bipedalism. Here we investigated MTPJ morphology in extant anthropoids and fossil hominins (including *Ardipithecus*, *Australopithecus* and early *Homo*) using shape and phylogenetic comparative methods to test hypotheses about the nature and timing of pedal evolution in Plio-Pleistocene hominins. Three-dimensional geometric morphometric techniques were used to quantify MT1-5 head shape. To identify adaptive shifts in the evolution of MTPJ morphology, we employed a Bayesian multi-optima Ornstein-Uhlenbeck analysis. Results show a consistent mosaic pattern across the forefoot of fossil hominins. Specifically, all hominins studied except *H. naledi* had a MT1 head shape outside the range of variation of modern humans, but also simultaneously possessed human-like lesser toes (a pattern also reported for the Burtule foot). Phylogenetic analyses confirm that evolutionary shifts occurred across major clades within anthropoids, including the hominins. Taken together, these findings confirm that the lateral aspect of the forefoot evolved towards a more human-like configuration before the medial forefoot (Lovejoy *et al.*, 2009).

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### From form to function: insights into tooth function through the study of variation in tooth root size and shape

CHRISTIANNE L. FERNEE<sup>1,2</sup>, KATHARINE R. BROWN<sup>2</sup>, ALEX DICKINSON<sup>3</sup>, CHRIS WOODS<sup>3</sup> and SONIA R. ZAKRZEWSKI<sup>1</sup>

<sup>1</sup>Archaeology, University of Southampton, <sup>2</sup>Archaeology and Anthropology, University of Bristol, <sup>3</sup>Bioengineering Science Research Group, University of Southampton

Hidden during life, tooth roots are often forgotten within dental research despite their crucial role in tooth function. This paper analyses differences in tooth root form in three populations, studying changes in tooth function over a 2000-year period from a microfocus computer tomography ( $\mu$ CT) dataset. The samples consisted of permanent incisors and canines from Roman (n=14), Anglo-Saxon (n=62) and Modern (n=60) (NRES ref.12. LO.0901) samples.

Age and sex was estimated for archaeological individuals, and wear was recorded qualitatively for all (Molnar, 1971). Specimens were  $\mu$ CT scanned in a 50mm diameter column in layers of 12-15 (Nikon/Metris HMX ST Scanner,  $\mu$ VIS, University of Southampton) at 110kV and 30 $\mu$ m resolution, giving volumetric datasets containing 1000x2000x2000 voxels. Enamel, dentine and whole-tooth surfaces were extracted by grayscale threshold segmentation, with virtual calculus

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removal, and aligned in space. The crown and root were then separated along the CEJ. Root length was taken by automated landmark identification, and root volume and surface area was calculated. Geometric morphometrics (GM) was used to obtain and analyse shape morphology, using a combination of landmarks (8), curve semi-landmarks (36) and surface semi-landmarks (200). GM was employed to overcome the problem of subjectivity and information loss encountered when relying on non-metric traits and metric measurements.

Tooth morphology has been acknowledged to reflect tooth function, however research has largely focused upon enamel thickness and microstructure. The results here support a relationship between root morphology and occlusal load, with root morphology acting as a possible indicator of changing dietary patterns and preparation practices.

AHRC-SWWDTP

### Using historic fixed soft tissues for retrospective genomic analyses: a methodological evaluation

GIADA FERRARI<sup>1</sup>, HEIDI E.L. LISCHER<sup>2,3</sup>, GÜLFIRDE AKGÜL<sup>1</sup>, FRANK J. RÜHLI<sup>1</sup> and ABIGAIL S. BOUWMAN<sup>1</sup>

<sup>1</sup>Institute of Evolutionary Medicine, University of Zurich, <sup>2</sup>Institute of Evolutionary Biology and Environmental Studies, University of Zurich, <sup>3</sup>Swiss Institute of Bioinformatics (SIB)

The investigation of ancient and historic pathogen genomes is of key importance for the study of the evolutionary genetics, history, and epidemiology of pathogens. While skeletal remains are often the only available source for ancient DNA studies on past pathogens, different kinds of preserved soft tissues also exist. These are, however, used far less often than skeletal material.

Wet specimens from anatomical and museum collections are particularly suitable for retrospective investigations of human pathogens due to their precise dating and diagnoses. However, the fixatives used to preserve these tissues, can often cause DNA degradation and may also act as inhibitors on downstream applications. Formalin is the most commonly used fixative in museums and anatomical collections. It contains formaldehyde, which induces cross-linking between nucleic acids and proteins, thereby acting as a strong inhibitor.

Here we present a methodological evaluation to test and adapt protocols at various steps of a typical high-throughput DNA sequencing workflow, in particular at the DNA extraction level. We are investigating both formalin-fixed tissues as well as tissues preserved in alcohol-based fixatives, and discuss if and under which conditions these specimens are a reliable source for the investigation of historic pathogen genomes.

### One Generation Evolutionary Signal from Human Whole-exome Sequencing Data

TATIANA FERREIRA DE ALMEIDA<sup>1</sup>, DANILO VICENSOTTO BERNARDO<sup>2</sup> and MARIA R. SANTOS PASSOS-BUENO<sup>1</sup>

<sup>1</sup>Genética e Biologia Evolutiva, Universidade de São Paulo, <sup>2</sup>Instituto de Ciências Humanas e da Informação, Universidade Federal do Rio Grande

Recent publications shows that even small evolutionary signals from recent human evolution can be detected with next generation sequencing data. The quantity of considered deleterious mutations has a direct correlation to the time of a specific population, evolving from its original ancestor, the strong selective forces and historical bottlenecks. All this events tend to have different effects on maintaining or withdrawing deleterious variants from generations. In this study we try to see if it is possible to observe such effect in only one generation. For this analysis, the whole-exome of 35 trios were sequenced using Illumina platform. The variants were separated into categories regarding their expected role in protein function (frameshift, stopgain/loss, splicing, nonframeshift indels, nonsynonymous and synonymous) and frequency (above 5%, between 5-1% and below 1%). Nonsynonymous variants were further separated into five categories regarding their predicted rank of pathogenicity. The number of variants for each category was counted for each subject. The covariance matrix for each group was calculated and the resulting matrix were compared between groups. The covariance matrices were compared using Spearman correlation test and significance was obtained with Mantel test. Correlation between mothers and children were 0.887 (p 9.999e-05), fathers and children 0.9129 (p 9.999e-05) and mothers and fathers 0.8449 (p 9.999e-05). This results shows that the covariance between groups are very similar and the high values for the father-children correlation still needs further studies.

### More than just menopause: Processes of female reproductive aging

KATHLEEN A. O'CONNOR<sup>1</sup>, REBECCA J. FERRELL<sup>2</sup> and DARRYL J. HOLMAN<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Washington, <sup>2</sup>Biological Anthropology Program, National Science Foundation, <sup>3</sup>Department of Anthropology, University of Washington

Female reproductive aging and fertility decline constitute a years-long process prior to menopause. Wood and colleagues' research used theoretical frameworks, laboratory methods, and mathematical modeling of biological processes to contribute detailed investigations of mechanisms of female reproductive aging. They collected daily and monthly reproductive hormone (hCG, steroids, gonadotropins) and menstrual cycle data to test models positing that features of reproductive

aging are consistent with a) increasing risk of fetal loss, and b) a model of follicular depletion, a system that paradoxically optimizes fertility in young adulthood. These studies found that the onset, trajectory and duration of reproductive aging indicators exhibited considerable heterogeneity across both cycles and women and were not strict functions of age, and that ovarian and hypothalamic-pituitary activity were themselves highly variable across the transition to menopause. Risk of fetal loss and elevated FSH were the earliest signs of reproductive aging, with decline of steroids occurring late in perimenopause. These and other results indicated that single intermittent measures do not capture the complex dynamics of aging, confounding easy characterization of individual reproductive status. Increasing risk of fetal loss and follicular depletion were supported as proximate causes of many, but not all, features of reproductive aging. This work highlights that declining reproductive function begins well before age 50 (modern median age at menopause), and that understanding the timing and nature of reproductive aging is necessary for evolutionary theories of human life history; focusing only on menopause misses critically informative elements of the process and timing of reproductive aging.

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### Electromyography, Kinematics, and Kinetics of the Upper Limb during Oldowan Stone Tool Manufacture

ELEN M. FEUERRIEGEL<sup>1</sup>, MARK HALAKI<sup>2</sup>, DARREN REED<sup>3</sup>, COLIN P. GROVES<sup>1</sup> and KAREN A. GINN<sup>3</sup>

<sup>1</sup>School of Archaeology and Anthropology, Australian National University, <sup>2</sup>Discipline of Exercise and Sport Science, University of Sydney, <sup>3</sup>Discipline of Biomedical Science, Sydney Medical School, University of Sydney

Past biomechanics research on stone tool manufacture has focused on the kinetics and kinematics of the upper limb, with particular emphasis on the role of the hand and wrist. The specific activity of the shoulder and elbow musculature, however, remains largely unknown. This information is vital for providing a complete picture of the functional demands that may have been acting on the early hominin upper limb. This study investigated the normal activation patterns of 15 shoulder and elbow muscles using electromyography (EMG), in addition to upper limb kinetics and kinematics, in 16 subjects during Oldowan stone tool manufacture. Results indicate that the stone knapping arm motion is a dynamic three-dimensional flexion-extension task with shoulder and elbow musculature primarily producing the acceleration of arm segments to generate the strike force. The segments of the upper limb moved in a coordinated sequence, originating with the shoulder

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proximally in the up-swing or “cocking” phase and moving through to the wrist and hammerstone distally in the down-swing phase. The major torque-generating muscles of the strike are the latissimus dorsi, teres major, and triceps brachii; pectoralis major works to decelerate the rapidly extending arm in the down-swing to improve strike accuracy. The wrist flexor and extensor musculature appear to be recruited to stabilise the elbow and wrist against reactive forces from hammerstone impact rather than producing motion of the wrist. Together these results present one of the first detailed investigations into upper limb muscle recruitment and kinematics in Oldowan stone tool manufacture.

### Intraspecific Variation in a Food Mechanical Property: The Ecology of Fruit Hardness for a Primate Food at Gunung Palung National Park, Indonesia

BENJAMIN J. FINKEL and ANDREW J. MARSHALL  
Department of Anthropology, University of Michigan

Food properties exert important evolutionary pressures on primate anatomy and behavior. Notably, interspecific variation in molar enamel thickness may reflect adaptations for processing tough foods. Yet as studies on plant chemical properties demonstrate previously ignored intraspecific variation in both toxins and nutrients, potentially analogous variation in mechanical properties remains unexplored. Spatial variation in predation risk, pathogens, and nutrient availability for plants suggest that the cost-benefit tradeoff of food mechanical properties may vary on small ecological scales. To test hypotheses that fruit hardness differs with ecological conditions, we sampled from a popular primate food, the liana *Strychnos* (*Loganiaceae*), across forest types within Gunung Palung National Park, Indonesia. Using puncture resistance, we measured 119 fruits from 15 individual lianas across distinct forest types: alluvial bench ( $n = 7$ ), lowland sandstone (87), and lowland granite (24). Fruits varied in mass (mean 49.28g, SD 17.94g) and puncture resistance (mean 135kg/cm<sup>2</sup>, SD 110kg/cm<sup>2</sup>). Formal model comparison indicates that the best model of variation in hardness (47% model weight,  $\omega$ ) includes forest type and mass; with larger fruit being harder and hardness highest in alluvial forest and lowest in lowland granite forests. The top three models ( $\omega > 99\%$ ,  $\Delta AIC \leq 2.2$ ) all include forest type and suggest potentially ecologically-relevant interactions between mass and forest type. These results stress the importance of plant sampling methods that consider local variation, pitfalls in extrapolating mechanical property values from one system to another, and intraspecific variation as a predictor of patch choice in foraging models.

### Are sexual swellings reliable indicators?

COURTNEY L. FITZPATRICK<sup>1</sup>, JEANNE ALTMANN<sup>4,5</sup> and SUSAN C. ALBERTS<sup>2,3,5</sup>

<sup>1</sup>Biology, Indiana University, <sup>2</sup>Evolutionary Anthropology, Duke University, <sup>3</sup>Biology, Duke University, <sup>4</sup>Ecology and Evolution, Princeton University, <sup>5</sup>Institute of Primate Research, National Museums of Kenya

The paradigm of competitive males vying to influence female mate choice has been repeatedly upheld, but, increasingly, studies also report competitive females and choosy males. One female trait that is commonly proposed to influence male mate choice is the exaggerated sexual swelling displayed by females of many Old World primate species. The reliable indicator hypothesis posits that females use the exaggerated swellings to compete for access to mates, and that the swellings advertise variation in female fitness. We tested the two main predictions of this hypothesis in a wild population of baboons (*Papio cynocephalus*). First, we examined the effect of swelling size on the probability of mate guarding (consortship) by the highest-ranking male and the behaviour of those males that trailed consortships (‘follower males’). Second, we asked whether a female’s swelling size predicted several fitness measures. We found that high-ranking males did not prefer females with larger swellings (when controlling for cycle number and conception) and that females with larger swellings did not have higher reproductive success. Our study, the only complete test of the reliable indicator hypothesis in a primate population, rejects the idea that female baboons compete for mates by advertising heritable fitness differences. Furthermore, we found unambiguous evidence that males biased their mating decisions in favour of females who had experienced more sexual cycles since their most recent pregnancy. Rather than tracking the potential differences in fitness between females, male baboons appear to track and target the potential for a given reproductive opportunity to result in fertilization.

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### Gait Asymmetry in Humans and Other Animals: How much is Normal and Why Does it Exist?

AIDAN Z. FITZSIMONS<sup>1</sup>, MICHAEL C. GRANATOSKY<sup>2</sup>, ROBIN M. QUEEN<sup>3</sup>, PIERRE LEMELIN<sup>4</sup>, ANGEL ZEININGER<sup>1</sup>, HENRY CHAPMAN<sup>1</sup> and DANIEL SCHMITT<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Department of Organismal Biology and Anatomy, University of Chicago, <sup>3</sup>Department of Biomedical Engineering and Mechanics, Virginia Tech, <sup>4</sup>Division of Anatomy, Department of Surgery, University of Alberta

Gait asymmetry (difference between left and right side limb behavior) is often used to measure recovery after clinical intervention and track changes in humans with neurodegenerative diseases. It is known that asymptomatic humans have some level of asymmetry. However, little information is available about how much asymmetry is typical and why asymmetry exists from an adaptive perspective. No data are available for asymmetry observed in bipedal or quadrupedal gaits of non-human primates and other animals. Asymmetry may promote flexibility and ability to adjust quickly to environmental variation in terrain. We hypothesize that asymptomatic humans and quadrupedal animals will have minimal limb asymmetry compared to humans with gait pathologies and animals adopting non-habitual gaits. Kinematic and spatiotemporal gait variables of 22 mammalian species were collected during steady locomotion and asymmetry was calculated between sides using a ratio of between limb difference over between limb average. Asymmetry was low for asymptomatic humans ( $3.4\% \pm 2.6$ ) and high for humans with pathological conditions ( $101.9\% \pm 74.2$ ) and bipedal chimpanzees ( $27.6\% \pm 7.9$ ), with remaining species averaging about 3%. For quadrupeds, differences in asymmetry between forelimb and hindlimb were only observed in five species of primates in which forelimb asymmetry values were higher (9.9%) compared to the hindlimb (6.3%). This study demonstrates that bilateral asymmetry is normal during steady locomotion in animals and that pathology or non-habitual gaits will result in greater asymmetry. Application of bilateral gait asymmetry analysis to non-human animals provides insight into species’ differences in neuromuscular control and valuable information about consistency of forelimb versus hindlimb movement.

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### Primate Communities: Behavior and Morphology

JOHN G. FLEAGLE<sup>1</sup>, KAYE E. REED<sup>2</sup>, NISA NAQVI<sup>3</sup> and JEROEN SMAERS<sup>4</sup>

<sup>1</sup>Anatomical Sciences, Stony Brook University, <sup>2</sup>Institute of Human Origins, Arizona State University, <sup>3</sup>Research Volunteer, Smithtown High School East, <sup>4</sup>Anthropology, Stony Brook University

Studies of primate community ecology are normally based on the extensive behavioral ecology data of extant taxa that were collected over the past five decades. However, living primates are just a part of diverse radiations that have evolved over the past 50 million years, almost all of which are known only from morphological remains. The goal of this study is to determine the extent to which analyses of morphological data from extant primate taxa generate results similar to those based on analyses of the

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behavior of the same taxa. Thus, we analyzed a series of morphological indices for extant species found in eight primate communities drawn from four major areas with distinct primate faunas - South America, Africa, Madagascar, and Southeast Asia. Morphological indices were used as surrogates for behavior data that were used in previous analyses. Morphological data used in the analyses include intermembral index (locomotion), shearing quotient (diet), and relative orbit size (activity pattern).

Many of the broad patterns found in the behavioral analyses were also found in the morphological analyses, including lower adaptive diversity in the South American communities than those in Madagascar, Africa and Asia. However, some details differed, likely due to issues of allometric scaling, alternative morphological solutions to functional problems, and phylogenetic constraints. Nevertheless, the overall results suggest that inclusion of extinct taxa in broad comparative analyses of community ecology are limited more by the completeness of fossil taxa rather than major differences in the ecological information available from morphological and behavioral data.

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### Ancient DNA Analysis of a Late 17<sup>th</sup> Century Plantation site in Delaware Yields Considerable Matrilineal Diversity and Relatedness in Early Colonists

RAQUEL E. FLESKES<sup>1</sup>, FRANKIE WEST<sup>2</sup>, GRACIELA S. CABANA<sup>2</sup> and THEODORE G. SCHURR<sup>1</sup>

<sup>1</sup>Anthropology, University of Pennsylvania,

<sup>2</sup>Anthropology, University of Tennessee

The 17<sup>th</sup> century Chesapeake Bay region represents an early locus of European settlement in North America to which both British migrants and African slaves were brought. However, relatively little research into the genetic diversity of these early colonists has been conducted, thereby limiting our understanding the settlement history and kinship patterns of this time period. Here, we present the first genetic findings for individuals who were buried at the Avery's Rest archaeological site near present day Rehoboth Beach, Delaware. This site contained a small plantation that was occupied from the late 1680s to the early 1720s. Previous osteological analysis indicated that 8 Europeans and 3 Africans were buried at the site, and separated by ancestry into two burial clusters. We successfully extracted DNA out of metatarsal, metacarpal, and rib samples from these 11 individuals at the University of Tennessee's Ancient DNA lab. We sequenced the entire mtDNA control region to determine the extent of haplotypic diversity in the individuals from the site. Our results verify the osteological determination of ancestry, and report the extent of mitochondrial diversity at the site. Our results indicate sharing of mtDNA haplotypes between individuals, suggesting they are matrilineal kin. In

addition, we explore the diversity of African mitochondrial haplotypes in relation to the slave trade. Overall, this work will contribute to an understanding of the settlement pattern in the early American colonial period and the socio-political forces that shaped it.

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### Micromorphological study of hypocellular human mastoids

STEFAN FLOHR<sup>1</sup>, ANNA K. BRESSLER<sup>1</sup>, HORST KIERDORF<sup>1</sup>, MICHAEL SCHULTZ<sup>1,2</sup> and UWE KIERDORF<sup>1</sup>

<sup>1</sup>Department of Biology, University of Hildesheim,

<sup>2</sup>Department of Anatomy and Embryology, University Medical School Goettingen

Mastoid hypocellularity is frequently observed in archaeological human skeletons. Morphologically, three types of hypocellularity have previously been distinguished (Flohr et al. 2009): Type I is characterized by an indistinct boundary between the pneumatized and the nonpneumatized portion of the mastoid, and a trabecular thickening in the transition zone; Type II exhibits a clearly defined border between the two portions with regular diploë in the nonpneumatized portion; Type III is characterized by dense bone formations in previously existing air cells.

Hypocellular mastoids of types I and III were analyzed by back-scattered electron imaging in the SEM, transmitted light microscopy, and fluorescence microscopy, to reconstruct the processes of bone formation in these types. The studied specimens originated from skeletons recovered from an early medieval cemetery in Dirmstein, Germany.

The compacted transition zone of type I hypocellularity mainly consists of woven bone, with some primary osteons and non-osteonal lamellar bone. Numerous reversal lines indicate extensive resorption of the previous diploë followed by bone formation, resulting in an overall increase of bone mass. In type III hypocellularity, new bone is deposited on the walls of previous air cells secondary to minor osteoclastic resorption. The dense bone formation within the former air cells apparently develops by the compaction of a preexisting scaffold.

While type III hypocellularity can plausibly be related to mastoiditis, it remains unclear whether or not type I hypocellularity is of pathological relevance. The micromorphological findings of the present study suggest that this type may reflect a chronic pathological condition.

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### Heterogeneity in Oral Health in Middle Tennessee during the Mississippian Period

CHRISTINA L. FOJAS

School of Science, Marist College

Frailty analyses have been employed to discern the relationship of pathological conditions and risk of death. It is hypothesized that individuals without markers of poor oral health have a greater age-specific risk of death than similarly-aged individuals with these markers. Skeletal remains from 12 sites dating to the Mississippian Period (ca. AD 1000-1500) in the Middle Cumberland Region of Tennessee were analyzed. Dental caries, dental abscesses, and antemortem tooth loss (AMTL) were examined and age-at-death was estimated using Transition Analysis. The MLE point estimate of age-at-death was calculated for each adult skeleton (n=550) and used in a series of Kaplan-Meier survival analyses and log-rank tests.

Individuals with abscesses lived eight years longer than those without abscesses (p=0.001). Individuals with AMTL survived an additional 10 years than individuals without AMTL (p<0.005). In contrast, individuals without carious lesions survived eight years longer than individuals with carious lesions (p=0.002). One way these results can be explained is in light of the age-progressive nature of dental attrition. Given masticatory demands, attrition is expected to increase with age. An individual needs to survive into adulthood in order for teeth to wear down to the extent of pulp exposure. The prevalence of skeletal lesions may serve as markers of survival and not necessarily poor health. These results demonstrate the coexistence of the traditional interpretation of skeletal lesions and that of the osteological paradox.

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### The Wrong Side of the Tracks: How Sociocultural Expectations Produce Vulnerability and Risk for Urban Mobile Home Dwellers

ALLISON FORMANACK

Anthropology, University of Colorado-Boulder

Manufactured (or mobile) homes comprise 8% of American housing stock with an estimated population of 20 million. Roughly one-third of all manufactured homes are sited in land-lease mobile home communities (MHCs). Drawing from ethnographic data collected in Nebraska over five years (2011-2016), I demonstrate how the dominant sociocultural devaluation of manufactured housing and mobile-homeowners as "trailer trash" creates and exacerbates resident vulnerability. Definitions of ownership in MHCs differ from the sociolegal norm in the United States: Landowners are recognized as the lawful

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titleholders of an MHC, whereas individual manufactured homes are titled as "unaffixed" personal property. This study considers how unequal tenant-landlord relations in MHCs perpetuate social, financial, health, and legal vulnerabilities for mobile-homeowners. Restricting manufactured housing from classification as real estate based on its material properties is linked to cultural anxieties regarding transience and threats to adjacent property values. That these fears remain potent despite contradictory evidence (Wubneh & Shen 2004) indicates that social stigma is the principle lens through which MHC knowledge, expertise, and opinion is circulated. To contextualize these effects, I present the case study of MHC redevelopment in Lincoln, Nebraska as evidence of how cultural devaluation is repackaged as legal and financial expertise in order to justify displacing thousands of mobile-homeowners. Approached from this perspective, I argue that the accelerated closure of MHCs nationwide is the result of policies of benign neglect concerning culturally-undesirable "trailer parks" and not purely the natural deterioration of presumably poorly-constructed homes.

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### Virtual reconstruction of the pelvic remains of KNM-WT 15000 *Homo erectus* from Nariokotome, Kenya

CINZIA FORNAI<sup>1,2</sup> and MARTIN HAEUSLER<sup>1,3</sup>

<sup>1</sup>Institute of Evolutionary Medicine, University of Zurich, <sup>2</sup>Department of Anthropology, University of Vienna, <sup>3</sup>Institute of Anatomy, University of Zurich

The KNM-WT 15000 *Homo erectus* pelvis is incomplete and fragmentary, which hampers a clear and confident interpretation of its morphology. In particular, the pubic bones are missing and the sacrum is very fragmentary and does not show the lateral portions of sacral alae. Additionally, all apophyses went lost and the triradiate suture is unfused because of KNM-WT 15000's young developmental age.

Previous descriptions of the Nariokotome boy pelvis have pointed out a mediolaterally constricted pelvic canal, short superior pubic rami and vertically developed iliac blades. However, these features are not found in the recently discovered adult female *H. erectus* pelvis from Gona, Ethiopia. This shows wide biacetabular distance, long superior pubic rami and laterally flaring iliac blades, and its species attribution has therefore been questioned.

We performed a virtual reconstruction of KNM-WT 15000 pelvic girdle. Initially, ilium and ischium were repaired merging right and left sides, which are differently broken. The remaining missing areas were integrated using

as templates other early hominin pelvic material and modern human pelvises at the same developmental age as KNM-WT 15000. Afterwards, possible realignments of the pelvic bones were tested. In addition, we produced a manual restoration of the pelvis using casts of the fragments to assist our virtual reconstruction.

Our reconstructions show that a rounder pelvis and more flaring ilia are well possible in KNM-WT 15000. This has implications for locomotion and body shape and matches the long femoral neck as well as recent suggestions for a wider lower thorax in KNM-WT 15000.

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### Conflict and warfare at the Chandman site (700-400 BCE), in northwestern Mongolia

DAVID FORNELL<sup>1</sup>, YAHAIIRA GONZALEZ<sup>2</sup>, PETER ANG<sup>3</sup>, CAIUS CHICKANIS<sup>4</sup> and CHRISTINE LEE<sup>5</sup>

<sup>1</sup>Anthropology, California State University, Los Angeles, <sup>2</sup>Anthropology, California State University, Los Angeles, <sup>3</sup>Anthropology, California State University, Los Angeles, <sup>4</sup>Anthropology, California State University, Los Angeles, <sup>5</sup>Anthropology, California State University, Los Angeles

The Chandman archaeological site is related to the Uyük culture in northwestern Mongolia and Tuva. They are a continuation of the Pazyryk culture. The Chandman inhabitants were semi-nomadic pastoralists. A total of 95 individuals were analyzed. The sex distribution of the site was unusual with 65 males, 28 females, and 2 indeterminate individuals. Twice as many males were present compared to females, and there were no children or infants. The pattern of cranial trauma was analyzed. Twelve individuals (13%) had signs of cranial trauma. This is not a high amount of trauma for the region, however the pattern of trauma is unusual. All cases of trauma occurred in males, no females had cranial trauma. The parietal was the most common location (14), then the frontal (12), temporal (5), and occipital (3). Slightly more injuries occurred on the right side (11) than on the left side (8). The weapons, which created the injuries, appear to be blunt instruments (club or maces), blade instruments (swords and arrow points), and high velocity projectiles (possibly crossbows?). A large proportion of traumas were located near the top of the head. These men were not wearing helmets during the attacks. The trajectory of the weapons also suggests they were attacked by people on horseback. It is possible this population was intrusive into the region creating conflict.

### Bipedal Loading Behaviors do Not Always Induce Cross-sectional Changes in Bone

ADAM D. FOSTER

School of Osteopathic Medicine, Campbell University

The evolution of human bipedalism involved significant changes in musculoskeletal morphology to accommodate a locomotor shift from quadrupedal to upright walking. One predominant feature linked with this transition are changes in bone cross-sectional morphology. Previous work suggests that differences in polar section modulus ( $Z_p$ ) are related to mechanical loading behaviors. Because bone adapts to the predominant forces placed upon it, experimentally altering mechanical loading regimes in an animal model allows for a natural test of the relationships between form and function. This study utilizes a novel method to experimentally induce a locomotor shift during ontogeny in a rat model. Rats (n=14) were placed in a custom harness system mounted on a treadmill which allowed for bipedal locomotion over 60 minute periods, 5 days a week, for three months, starting at 4 weeks of age. The harness imparts an adjustable upward force on the torso which alters the load experienced by the hindlimbs. Here, this group was compared to a quadrupedal control group that was exercised for the same period and a no activity control. At the end of the experiment,  $\mu$ CT scans were taken to measure  $Z_p$  at the distal and proximal diaphysis ( $30\% \pm 5\%$  and  $70\% \pm 5\%$ ) for the femur. Using a linear mixed-effect model, no significant differences were found between the bipedal and control groups ( $70\% p=0.383$ ;  $30\% p=0.983$ ). These results build upon previous preliminary findings and suggest that adopting a bipedal locomotor gait during ontogeny isn't enough to alter cross-sectional geometry anywhere in the femoral diaphysis.

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### Kinematic Effects of Body Size Differences during Walking

MARIA C. FOX<sup>1</sup>, KATHERINE K. WHITCOME<sup>2</sup> and JOHN D. POLK<sup>1</sup>

<sup>1</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>College of Health Sciences, California Northstate University

Body size differences have numerous effects on posture and gait. Scaling principles suggest that smaller mammals use flexed postures to improve acceleration and maneuverability, whereas larger mammals use more extended limbs but experience kinematic constraints (Alexander and Jayes, 1983; Biewener, 1989). Whether these principles apply to humans is unclear; current studies report conflicting results. This research examined 34 adults to determine if angular kinematics differ with height and measures of limb length at two walking speeds. Univariate and multivariate

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statistics explored relationships between height and kinematic variables; analyses were stratified by sex when necessary to avoid conflating effects of sex and size. Regression analyses revealed increased thigh flexion at heel strike in shorter individuals ( $r=0.55$  (male slow),  $r=0.24$  (female slow),  $r=0.40$  (male fast),  $r=0.31$  (female fast)). Canonical correlations analysis confirmed that limb length variables vary inversely with thigh angle and that greater thigh flexion accompanies greater foot dorsiflexion at heel strike ( $p < 0.0001$ ). Increased thigh angle may suggest more hip flexion or a longer relative stride length in shorter individuals, the latter of which is confirmed by regression analysis in this sample ( $p < 0.0131$ ). Shorter individuals also had greater relative stride frequencies at both speeds ( $p < 0.0001$ ). Some of these differences (stride frequency and length) are due to the use of constant speeds, but others (such as foot posture) suggest true functional consequences. This initial analysis confirms that kinematics differ in humans of varying sizes and likely have effects on locomotor performance and behavior.

### Evolutionary perspectives on dementia and the marginalization of the elderly

MOLLY FOX

Department of Anthropology, UCLA

In most of the developed world today, societies are structured such that the elderly are removed from mainstream activity and neglected by younger people. This social organization is markedly distinct from pre-modern human societies, in which elders likely played central cultural and functional roles. Furthermore, the prevailing theory for the evolution of human longevity relies on the idea that grandmothers could maximize their inclusive fitness by teaching, passing down information, and subsidizing their adult children's labor and energetic needs. However, if one in six women developed dementia in the past as today, this would call the grandmother model into question. The disadvantage and burden that dementia places on families alongside its high prevalence would compromise selection for longevity. Here, I propose a hypothesis that age-matched dementia rates were lower in the past compared to today. I present results from my cohort study of British women, demonstrating more traditional reproductive life-history patterns are associated with lower dementia risk, supporting the possibility that dementia rates were lower in the pre-modern past. Lower risk of dementia in the past would bolster the credibility of grandmothers models for the evolution of human longevity. If elderly people had better cognitive health than today, they would have been more able and likely to participate fully in mainstream society. These results have implications for ethical and humanitarian issues about how the elderly should be treated, and may contribute

to greater appreciation for inclusion of the elderly in society as a key feature of human identity and history.

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### As Tall as Goliath? Stature Among the Philistines at Ashkelon

SHERRY C. FOX<sup>1</sup>, KATHRYN MARKLEIN<sup>2</sup>, RACHEL KALISHER<sup>3</sup>, MARINA FAERMAN<sup>4</sup>, PATRICIA SMITH<sup>4</sup>, DANIEL MASTER<sup>5</sup> and ADAM AJA<sup>6</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Anthropology, Ohio State University, <sup>3</sup>Department of Anthropology, New York University, <sup>4</sup>Dental Medicine Department, Hebrew University, <sup>5</sup>Biblical and Theological Studies, Wheaton College, <sup>6</sup>Semitic Museum, Harvard University

During the 2013-2016 field seasons of the Leon Levy Expedition to Ashkelon, approximately 215 individuals have been recovered from the Philistine cemetery dating to the Iron Age IIA period, providing for the first time an opportunity to study the stature of the "tall-tailed" Philistines. Extensive research in human biology and bioarchaeology has frequently demonstrated the direct correlation between stature and both health and socioeconomic status. *In situ* measurements utilizing an anthropometer and GIS reconstructed lengths provide approximate living statures for 16 individuals from the Philistine cemetery at Ashkelon. Maximum lengths (crown-to-heel) of complete, supine and extended skeletons—8 males and 8 females—are compared between sexes. The mean stature for males is 154.6 cm with a range of 144.9 cm – 164.5 cm, while the mean stature for females is 147.2 cm with a range of 136.8 cm to 152.8 cm. Although male and female stature ranges overlap, Student's *t*-tests reveal statistically significant ( $p < 0.05$ ) differences in the statures between the sexes. Despite these results, 4.7% sexual dimorphism in stature is relatively low, suggesting stress among individuals at the site. Comparisons in stature with the human skeletal remains from earlier Canaanite contexts at Ashkelon are limited due to the small sample size. Contrary to the stature of the most famous Philistine, the giant Goliath, the results of this study indicate that the Philistines were relatively short in stature at Ashkelon.

### Dating Behaviors and Attitudes among Single Parents in the U.S

CAROL Y. FRANCO<sup>1</sup>, PETER B. GRAY<sup>1</sup>, JUSTIN R. GARCIA<sup>2,3</sup>, AMANDA N. GESSELMAN<sup>2</sup> and HELEN E. FISHER<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Nevada, Las Vegas, <sup>2</sup>The Kinsey Institute for Research in Sex, Gender, and Reproduction, Indiana University, Bloomington, <sup>3</sup>Department of Gender Studies, Indiana University, Bloomington

Although a significant body of research has examined dating behaviors among men and women, few studies have investigated the role that children play in singles' dating relationships. An evolutionary life history framework suggests that single parents face trade-offs between mating and parenting effort. Here, our aim was to understand the ways in which having a child from a previous partner influence one's dating behaviors and attitudes. We expected to observe gender and age differences in dating attitudes and behaviors, such that women and younger participants would be more discerning about how and when to involve their children in their dating lives. As part of the Singles in America study, we obtained data from a U.S. sample consisting of 747 single men and women with a child under the age of 18. Participants completed an online survey. We conducted 16 regression models—binary logistic for dichotomous outcomes and linear for continuous outcome variables—using age and gender as predictor variables. Men and women reported differences in the types of romantic activities they deemed appropriate, such as holding hands or going away for a weekend with a partner. Although few participants reported having lied in order to obtain a date, those who did tended to be younger. Men and women were willing to date other single parents, and considered their child's opinion of potential partners. This is the first investigation of the role of children in parent's romantic lives across the lifespan and the largest quantitative study on dating among single parents.

*The Singles in America study is funded by Match.com*

### Rapid, Inexpensive Genotyping and Barcoding of Primates: Multiple Applications for High-resolution Melt Analysis in Primatology and Anthropology

DAVID C. FRANKEL<sup>1</sup>, RACHEL L. JACOBS<sup>1</sup>, EDWARD E. LOUIS JR<sup>2</sup>, WILLIAM D. HOPKINS<sup>3</sup> and BRENDA J. BRADLEY<sup>1</sup>

<sup>1</sup>The Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>2</sup>Conservation Genetics Department, Omaha's Henry Doorly Zoo and Aquarium, <sup>3</sup>Neuroscience Institute and Language Research Center, Georgia State University

Research in molecular ecology and conservation genetics often entails genotyping single nucleotide variants (SNVs) and/or short haplotypes. High-Resolution Melt Analysis (HRMA) is a simple and economical method for detecting such DNA variants by characterizing the sequence-specific melting behavior of short PCR products. To-date HRMA protocol development has focused largely on medical screenings, but this method has numerous potential applications in anthropological genetics. We developed and tested (via Sanger sequencing) several protocols demonstrating the utility, convenience and flexibility of HRMA in

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anthropological studies. First, we assessed the potential use of HRMA to characterize functional SNVs in wild populations by genotyping exons 3 and 5 of the X-linked opsin gene in lemurs (9 species, 87 individuals). Differences in melting curves (temperature and shape) allowed us to reliably identify trichromatic and dichromatic individuals with high accuracy. Second, we tested SNVs commonly used in association studies of autism and behavioral tendencies (rs2254298 and rs11131149, oxytocin receptor gene, *OXTR*). Again, we were able to accurately assign genotypes (AA, AG, GG) for the full set of 60 humans based on differences in genotype-specific melting curves. Finally, we are using HRMA for rapid species identification using a segment of cytochrome c oxidase 1 (*COX1*) as a barcode. Preliminary results indicate that sympatric lemur species and ape sub-species can be accurately identified and differentiated using HRMA. Our results demonstrate that HRMA, which can also be used in studies of methylation, microsatellite genotyping, and copy number variation, is a multipurpose and robust method for genotyping simple polymorphisms.

### Game of bones: intracranial and hierarchical perspective on dietary plasticity in mammals

ERIN M. FRANKS<sup>1</sup>, JEREMIAH E. SCOTT<sup>2</sup>, JOSEPH P. SCOLLAN<sup>1</sup>, KEVIN R. MCABEE<sup>1</sup> and MATTHEW J. RAVOSA<sup>1,3,4</sup>

<sup>1</sup>Biological Sciences, University of Notre Dame,

<sup>2</sup>Anthropology, Southern Illinois University,

<sup>3</sup>Aerospace and Mechanical Engineering, University of Notre Dame, <sup>4</sup>Anthropology, University of Notre Dame

The effect of dietary properties on craniofacial form has long been the focus of functional and paleontological studies, with extensive work dedicated to the importance of phenotypic plasticity. Previous studies have investigated plasticity of the masticatory apparatus with limited consideration of other cranial sites. Additionally, a thorough analysis of adaptation at multiple levels has been lacking, a noticeable oversight given the hierarchical organization of bone. Accordingly, there is a significant gap in our understanding of dietary effects on regional and hierarchical variation in the developing skull and feeding apparatus.

Twenty weanling *Oryctolagus cuniculus* were divided equally between two dietary cohorts and raised until one year old. Control rabbits were fed pellets only. Over-use rabbits were given pellets and hay cubes for the duration, modeling a mechanically challenging diet. MicroCT occurred biweekly to detail macro- and micro-scale morphological changes across multiple craniomandibular sites. Nanoindentation was employed post-sacrifice to detail nanoscale properties of corresponding regions. Results indicate that diet-induced differences in loading

influences plasticity in masticatory elements without corresponding changes in the neurocranium, suggesting regional variation in response to mechanical forces. More specifically, the presence and magnitude of bone adaptation varies according to the level of analysis. This is critically important as it suggests that a functional signal may be differentially represented at one level of organization vs. another, potentially posing an issue for accurate behavioral reconstructions. These findings highlight functional and developmental variation in determinants of morphological integration in the skull, information of utility for ecomorphological, paleobiological, and evolutionary research.

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### Assessment of Cortical Thickness as a Non-Specific Indicator of Stress in Bone: An Experimental Animal Model

TUESDAY M. FRASIER<sup>1</sup>, MARTA P. ALFONSO-DURRUTY<sup>1,2</sup> and DUSTIN HEADLEY<sup>3</sup>

<sup>1</sup>Sociology Anthropology and Social Work, Kansas State University, <sup>2</sup>Departamento de Antropología, Universidad Alberto Hurtado, <sup>3</sup>Interior Architecture and Product Design, Kansas State University

Cortical thickness has been occasionally used as a non-specific indicator of stress to study past population's health status. However, further study, based on experimental models, is needed to assess cortical thickness potential as a non-specific marker of stress. Using an experimental animal model, this study evaluates cortical-thickness response to nutritional conditions. The cortical thickness was assessed in the osteological remains of 45 New Zealand White rabbits (NZW). During their developmental period, NZW were divided into three dietary groups; Control (normal diet), Experimental-1 (chronically undernourished), and Experimental-2 (periodically fasted). The left humerus and femur were CT scanned and the cortical thickness in the anterior aspect at the 40% maximum length site of both bones was measured in mm using the imaging software 3-D slicer. Cortical thickness in the femur showed to be similar the Control ( $\bar{x}$ ...=1.22, SD=.25), Experimental-1 ( $\bar{x}$ ...=1.27, SD=.31) and Experimental-2 groups ( $\bar{x}$ ...=1.48, SD=.28). Likewise, results for the humerus's cortical thickness showed the Control ( $\bar{x}$ ...=1.39, SD=.36), Experimental-1 ( $\bar{x}$ ...=1.30, SD=.39) and Experimental-2 ( $\bar{x}$ ...=1.63, SD=.23) to be similar. Comparisons between the groups failed to reveal any significant difference between the groups ( $p>.05$ ). Thus, preliminary results suggest that cortical thickness is not sensitive to general nutritional stress, or that the nutritional treatments were not severe enough to alter the cortical thickness of these NZW. Further analyses of other

sites in these two bones are needed, and other experimental studies are also required to assess the sensitivity of cortical thickness to stresses, and its potential as a non-specific stress marker in past populations.

### Craniometric Variation in the Modern Thai Population: Forensic Applications and Population History Implications

LAUREL FREAS<sup>1</sup>, PASUK MAHAKKANUKRAUH<sup>2</sup>, KARNDA VICHAIKAT<sup>3</sup>, PANYA TUAMSUK<sup>4</sup> and APICHA SINTHUBUA<sup>2</sup>

<sup>1</sup>Central Identification Lab, Defense POW/MIA Accounting Agency, <sup>2</sup>Department of Anatomy, Chiang Mai University, <sup>3</sup>Department of Forensic Medicine, Chiang Mai University, <sup>4</sup>Department of Anatomy, Khon Kaen University

Craniometric data have broad application in Southeast Asian (SEA) research contexts, ranging from forensic anthropology to studies of biological distance and population history among the temporally and geographically distinct peoples of the region. A core question in SEA prehistory relates to the biological continuity, or discontinuity, between the region's pre- and post-Neolithic populations. Some have argued this issue will only be understood through deeper, more focused sampling of the salient populations. Prior biological distance studies, however, have only shallowly sampled modern and ancient SEA populations, and have lacked craniometric data allowing examination of within-population patterns of regional/temporal variation. Likewise, extant forensic anthropology databases lack reference datasets of sufficient robusticity to characterize the true range of variation within and among SEA populations.

To begin to address these shortcomings, 24 standard cranial measurements were collected on a large sample ( $n=429$ ; 242 males/137 females) derived from three regional skeletal collections within Thailand. Beyond generating accurate linear discriminant functions for sex determination, these craniometric data were used to explore patterns of regional, within-population variation in juxtaposition to observed patterns of phenotypic variation within the living Thai population. ANOVA and discriminant function analyses found no significant craniometric differences among the three regional subpopulations, despite their apparent ethnic, linguistic, and physical diversity, indicating relative craniometric homogeneity within the modern Thai. This finding is congruent with known historical events that have clearly shaped the biological structure of this population, but that are often overlooked by prehistorians making comparisons between the modern and ancient populations of SEA.

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### Variation in Sympatry Among Crowned Lemurs and Sanford's Lemurs: A Comparison Between Mt. d'Ambre National Park and Analabe Gallery Forest

BENJAMIN Z. FREED and KATHERINE O. ARTHUR  
Anthropology, Sociology, and Social Work, Eastern Kentucky University

Congeneric lemur species often co-occur in several ways. For example, in Mt. d'Ambre National Park, Freed (1996) showed that crowned lemurs (*Eulemur coronatus*) and Sanford's lemurs (*Eulemur sanfordi*) shared the habitat primarily by relying on superabundant food resources, preferring different forest levels, using different food species, and traveling differently. To examine whether these results were unique to Mt. d'Ambre, or perhaps reflected species-wide differences, we collected 180 hours of quantitative behavioral data on these lemurs in June-August 2016 at Analabe, a small gallery forest that contained a dense understory, more human disturbance, and fewer large fruit trees. We hypothesized no differences with the Mt. d'Ambre population. Unlike Mt. d'Ambre, we observed fewer differences in vertical range use, with both species often using the canopy and emergent layer. Both lemurs also consumed similar plant species, using superabundant *Lantana camara* fruit, and supplementing it with seasonal food items (especially *Ficus* fruit and *Ceiba pentandra* flowers). As in Mt. d'Ambre, the lemurs also formed polyspecific associations, and often responded to each other's alarm calls. The greatest between-species differences occurred in ranging behavior, as crowned lemurs formed subgroups and ranged significantly farther daily (greater than 100 meters), much as they did in Mt. d'Ambre. Although both species showed fewer differences in habitat use than was observed in Mt. d'Ambre, we believe that both species' reliance on resource partitioning and superabundant resources reflects both a general ecological trend among lemurs, as well as subtle but significant differences in traits such as body size.

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### Environment resources use of Rio De Janeiro's state coast by shellmound builders: an estimate of diet composition

VICTOR GUIDA, MURILO BASTOS, SILVIA REIS and CLAUDIA RODRIGUES-CARVALHO  
Department of Anthropology, Museu Nacional/UFRJ

Shellmound builders initiated the occupation of Rio de Janeiro's coast around 8,000 BP, altering the environment by using its resources for feeding and for construction of tools and fire pit. Archaeological sites, such as shellmounds and other coastal sites, that contain traces of human populations' activities are commonly found at

lake systems' interior throughout the coast of Rio de Janeiro's state.

In order to broaden the knowledge about the use of environment resources by these groups, this study intends to estimate their diet by analyzing human skeletal and biota remains from two sites, Duna Grande and Sambaqui do Moa. Duna Grande is a coastal dune archaeological site located at Lagoa de Itaipu in Niteroi, RJ, and Sambaqui do Moa is a shellmound situated at Lagoa de Saquarema in Saquarema, RJ.

A total of 18 individuals were used in osteobiography and oral health analysis. The latter consisted in tooth wear analysis and presence of calculus and caries. To assess which plants and animals were probable consumed by shellmound builders, zooarchaeological and archaeobotanical data were retrieved from previous studies about the two archaeological sites.

Oral health analysis showed severe tooth wear and presence of calculus in the majority of individuals. No signs of caries were found. Regarding the biota, 92 animal taxa and 36 plant taxa were found.

Results from oral health and biota analysis corroborates a model of a protein based diet, composed mostly of fish, expanding the knowledge about resource use by shellmound builders in Rio de Janeiro's coast.

### Early Spanish Colonialism in Northern Guatemala: Identifying Itza Mayas at the Mission San Bernabé using Strontium, Carbon, and Oxygen Isotope Assays and Biodistance Analyses

CAROLYN FREIWALD<sup>1</sup> and KATHERINE MILLER WOLF<sup>2</sup>

<sup>1</sup>Sociology and Anthropology, University of Mississippi, <sup>2</sup>Sociology, Anthropology, and Geography, Indiana University East

Colonialism came late to northern Guatemala. After initial contact between the Spanish and the Itza Mayas in AD 1525, it was not until the early 18<sup>th</sup> century that the Spanish gained control over Maya groups living in the Petén Lakes region and began to establish missions. 2011-2012 excavations at the Mission San Bernabé on Lake Petén Itza discovered European goods, non-native animal species, and even burial patterns that differed significantly from earlier settlements. Cows, pigs, majolica ceramics, coins, and metal objects mark the introduction of a new lifestyle, as do High and Later Medieval style burials in and around the mission church. We describe these findings and present biodistance analyses of the 47 individuals in mission burials and strontium, carbon, and oxygen isotope assays of 23 of these individuals to understand who was buried in San Bernabé. Did the Spanish encourage – or force – relocation of populations from other areas under

Spanish control? Were non-Maya individuals interred in the mission? Our results show in-migration from Belize, a region already subject to Spanish rule. However, bioarchaeological data are not consistent with large population movements reported in Spanish documents. We found instead that the church cemetery contained mostly related groups of Maya individuals who likely had origins in the Petén Lakes region, suggesting some continuity in populations before and after Spanish rule began. We explore how new material culture at San Bernabé reflected important changes, as well as continuity, in local and/or regional Itza Maya communities.

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### Growth of the Catarrhine Ectotympanic Tube

ELLEN E. I. FRICANO<sup>1</sup> and VALERIE B. DELEON<sup>2</sup>

<sup>1</sup>Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>2</sup>Department of Anthropology, University of Florida

Ectotympanic bone morphology is a classic character used to differentiate between catarrhine and platyrrhine primates; though it has been frequently cited in academic literature, it is currently not well understood. Certain primate fossils have even been described as having intermediate conditions, or an abnormally short ectotympanic tube as compared to modern catarrhine. This project illustrates the growth and development of the ectotympanic tube as seen in one group of catarrhines, *Homo sapiens*.

A modern sample of 49 juvenile human crania were evaluated, between the mid-fetal period and nine years old. The development of the ectotympanic tube was also scored non-metrically using previously published standards. Pronounced anterior and posterior tympanic tubercles are present as early as one month postnatal. The tube continues to ossify, remaining roughened and ragged for some time, and generally smoothing out by age six. The ectotympanic tube undergoes a period of rapid ossification between ages one and two. In addition to the ossification of the ectotympanic tube, the tympanic ring shifts orientation, gradually becoming more vertical. The roof of the ectotympanic tube and the tympanic plate both expand laterally through development at different rates, eventually meeting and forming the adult external auditory meatus. In this sample, relatively brachycephalic juveniles did not present particularly developmentally advanced ectotympanic tubes. However, wider cranial bases tend to coincide with more advanced ectotympanic development indicating the growth of the ectotympanic tube may be a

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response to the re-orientation necessary as the cranial base widens.

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### Skull shapes, maps and museum collections: Representing modern human cranial variation

MARTIN FRIESS<sup>1</sup> and MANON GALLAND<sup>2</sup>

<sup>1</sup>HNS, Musée de l'Homme, <sup>2</sup>School Of Archaeology, University College Dublin

Our understanding of morphological variation in humans, and our ability to identify its causes in an evolutionary context relies upon documenting and quantifying this variability via the study of anthropological collections. This was perfectly demonstrated by WW Howells in his seminal work on cranial variation in man. Many anthropological collections originate in the 19<sup>th</sup> and early 20<sup>th</sup> century, when typological concepts dominated biological anthropology. The assumption that the collections housed in major museums are truly and equally representative of modern human cranial diversity remains somewhat hypothetical. We collected morphometric data from 520 modern human skulls, representing ten geographically diverse populations, in four major natural history museums around the world. We investigate the question to which extent these collections yield comparable results regarding phenetic affinities in modern human populations. We applied geometric morphometric methods to conventional landmark data, and explored population affinities via standard multivariate statistics. The results, while reassuring in that geographic origin is a major driving force of modern human cranial variation, clearly suggest that the other sample origin, i.e. the museum, adds statistically significant variation. Among the potential explanations for these findings are recruitment bias due to historical parameters surrounding the collecting of specimens, changes in measurement technique over time, as well as actual within-group diversity. Further research is required to narrow down the root of these findings. For the time being, we feel that researchers in the field of cranial variation should be aware of potential collection diversity and sample as largely as possible.

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### Pliocene African Cercopithecoid Evolution, Turnover and Diversity

STEPHEN R. FROST

Anthropology, University of Oregon

A striking feature of cercopithecoid evolution is the even pace of species turnover. Nonetheless, there are significant changes during the Pliocene. One major shift is the rise of *Theropithecus* in eastern Africa: although present by 4 Ma, *Theropithecus* becomes the predominant primate in the region by 3.6 Ma after which it accounts for more than 75% of cercopithecoid fossils at most sites. This may be related to a dietary transition to grazing

and parallels shifts to C4 diets by hominins and suids. This is regional as *Parapapio* predominates in southern Africa during the Pliocene while *Theropithecus* is typically present, but rare. Furthermore, there is variation within eastern Africa: in the Afar Region the *T. oswaldi* lineage is the sole theropithecoid whereas in the Turkana Basin, *T. brumptii* is also present and much more abundant than *T. oswaldi* prior to 2.3 Ma. In eastern Africa, this "*Theropithecus* zone" continues until the middle Pleistocene. However, in southern Africa *Parapapio* is replaced by *Papio* as the predominant genus approximately 2 Ma. In eastern Africa, large-bodied colobines are common and diverse taxonomically and ecologically. *Cercopithecoides* is the only colobine in the southern African Plio-Pleistocene. There are also differences within eastern Africa: only one of eight colobine species are shared between the Afar and Turkana Basins during the Pliocene, whereas in the Pleistocene 2 of 5 are. In summary, cercopithecoid faunas are more regionally distinct in the early Pliocene and become more similar through time within eastern Africa and between eastern and southern Africa.

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### Ecological niche modeling of the genus *Papio*

AMANDA J. FUCHS<sup>1</sup>, CHRISTOPHER C. GILBERT<sup>1</sup> and JASON M. KAMILAR<sup>2</sup>

<sup>1</sup>Department of Anthropology, Hunter College, City University of New York, <sup>2</sup>Department of Anthropology, University of Massachusetts, Amherst

Ecological niche modeling (ENM) has been used to assess species diversity and delineation in relation to abiotic factors. In this study, we use ENM to investigate how niches vary across *Papio* species in an attempt to understand the ecological or climatic variables that have influenced their taxonomic diversity. Using Maxent to generate niche models, we collated locality data for six *Papio* species and climate information from WorldClim. If niche models have good predictive power, *Papio* species distributions should be highly correlated with climatic factors. If niche models perform poorly, it may indicate that species are ecological generalists and their distribution is not highly correlated with climate. Our models performed moderately to extremely well depending on the species, which suggests climatic variables influence the distribution of baboon species to varying degrees. The species with the best models include *P. papio* and *P. kindae*, whereas *P. hamadryas* had the poorest models, possibly influenced by their very recent divergence from other populations. In addition to niche models, we examined the degree of niche overlap among all possible pairs of taxa, which can provide insight into patterns of species diversity. We found that most species pairs exhibited significantly different niches. However, pairwise comparisons between *P. hamadryas* and *P. anubis*, *P. hamadryas* and *P. cynocephalus*, and

*P. anubis* and *P. cynocephalus* were no different than random. The results of these models generally support a parapatric speciation scenario for the genus *Papio*. Furthermore, these results perhaps challenge the common perception that *Papio* species are ecological generalists.

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### Belief(s), Identity, and Experience: Navigating Multiple Influences on Knowing in Biological Anthropology

AGUSTIN FUENTES

Anthropology, University of Notre Dame

Recently there is a surge of empirical and philosophical research on the evolutionary history of *Homo sapiens*, the processes and outcomes of inequality and embodiment, and what it means to be human. This research and its popular interpretations have sparked heated debates about the nature of human beings and how knowledge about humans should be properly understood. These debates involve a wide range of participants from diverse experiential, intellectual, and philosophical backgrounds. Biological anthropology sits at the nexus of these concerns and is critically situated to play a key role in shaping and navigating this discourse. But to do so successfully we must acknowledge assumptions about normativity(ies) and how they structure the bioanthropological endeavor. There is often bias in our teaching and practice. Heteronormativity, assumptions about the structure of families and the meaning of religious beliefs, myopia about white and male privilege, and English language hegemony can all influence how we ask questions and shape the opportunities we have to ask them. How *do*, *could* and *should* belief systems, lived experience, sexual, gender, ethnic, national, and racial diversity play a role in how we "do" biological anthropology? Here I present examples of these interfaces, biases and conflicts, and offer a few options for facilitating positive outcomes. If our goal is to produce better knowledge about humans and non-humans, the connections between bodies, biology, and culture, and the politics and practice of science, biological anthropology needs to engage diversity critically, intimately, and courageously.

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### Association of ACE haplotypes and family members in social networks with blood pressure variation in African Americans

KIA C. FULLER<sup>1,2,3</sup>, CHRISTOPHER MCCARTY<sup>3,4</sup>, RAFFAELE VACCA<sup>5,6</sup>, CLARENCE C. GRAVLEE<sup>2,3</sup> and CONNIE J. MULLIGAN<sup>2,3</sup>

<sup>1</sup>Genetics and Genomics Graduate Program, University of Florida, <sup>2</sup>Genetics Institute, University of Florida, <sup>3</sup>Department of Anthropology, University of Florida, <sup>4</sup>Bureau of Economic and Business Research, University of Florida, <sup>5</sup>Clinical and Translational Science Institute, University of Florida, <sup>6</sup>Department of Sociology and Criminology & Law, University of Florida

## ABSTRACTS

In the US, African Americans experience hypertension at higher rates than other racial groups. This study focuses on a biocultural approach that integrates genetic and sociocultural data to investigate blood pressure variation in 138 African Americans living in Tallahassee, FL. Saliva samples, anthropometric data, blood pressure readings, and sociocultural data were collected from participants. To investigate potential genetic risk factors for hypertension, haplotypes were determined for three SNPs and one *Alu* polymorphism in the angiotensin I converting enzyme (*ACE*) gene. We also analyzed personal social networks to examine the social environment of participants.

To more thoroughly investigate the relationship between the *ACE* gene and BP, we used multiple genetic variants to identify haplotype blocks in the gene. Using AIC modeling and multiple linear regression models, we found a significant relationship between *ACE* haplotype and systolic (haplotype 1  $p$ -value=0.004, haplotype 2  $p$ -value=0.0002) and diastolic blood pressure (haplotype 2  $p$ -value=0.011). In previous studies, we found an interesting relationship between family members in networks and blood pressure. In new analyses, we found that central positions in a network occupied by family members was significantly associated with increased systolic blood pressure ( $p$ -value=0.020) and a larger percentage of family members in a network was significantly and positively associated with increased diastolic blood pressure ( $p$ -value=0.009). Our research shows that combining genetic and social network data explains more variation in blood pressure than either set of variables do individually and, thus, supports the value of a biocultural approach to investigate risk of hypertension in African Americans.

Supported by NSF Grants BCS 0820687 and BCS 0724032.

### Automatic segmentation of morphological structure into biologically corresponding features: implications for systematics and ecomorphology

ETHAN LUCAS. FULWOOD<sup>1</sup>, TINGRAN GAO<sup>2</sup>, INGRID DAUBECHIES<sup>2,3</sup> and DOUG M. BOYER<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Mathematics, Duke University, <sup>3</sup>Electrical and Computer Engineering, Duke University

The occlusal surfaces of mammalian teeth can be decomposed into structures of hypothesized homology, the shapes and positions of which are believed to reflect dietary adaptation. Testing the particular importance of the regional geometry of teeth has been hampered by difficulty in defining objectively and repeatably the boundaries of occlusal regions. We employ a novel feature extraction technique based on an extended diffusion geometry framework from manifold learning

on a sample of 48 second lower molars from five genera of New World monkeys. The technique automatically segments each tooth into 12 regions, 6 of which correspond to commonly identified structures of the tooth crown (protoconid, metaconid, entoconid, hypoconid, trigonid basin, and talonid basin). Both Dirichlet Normal Energy (DNE) and relative area of the metaconid, entoconid, and talonid basin and the areas of the trigonid basin were significantly different among genera. The entoconid and metaconid showed the clearest dietary signal using both metrics, with the two folivorous taxa (*Alouatta* and *Brachyteles*) significantly different from all of the other genera (*Ateles*, *Callicebus*, and *Saimiri*). Discriminant Function Analysis (DFA) using either areas or DNE of the 12 segments, correctly classified >95% of cases to dietary ecology or genus. Features loading the first linear discriminant differed depending on variable type and grouping criterion, but the entoconid was strongly influential on the linear discriminant in all analyses. This provisional analysis suggests the potential utility of automatic segmentation of molar surfaces characterizing taxonomically diagnostic morphology and in isolating structures varying most strongly with dietary ecology.

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### Experiments with extensions of the Siler model

TIMOTHY B. GAGE<sup>1,3</sup> and JEFFERY S. NAPIERALA<sup>2,3</sup>

<sup>1</sup>Anthropology, University at Albany SUNY, <sup>2</sup>Sociology, University at Albany SUNY, <sup>3</sup>Center for Social and Demographic Analysis, University at Albany SUNY

A frequent problem when attempting to estimate a life table using anthropological data is the inability to control for population growth,  $r$ . If growth is positive mortality is over estimated while if growth is negative mortality is underestimated. Wood, et al. 2002 suggested it might be possible to estimate  $r$  and a life table (controlling for  $r$ ) simultaneously by fitting the Siler model to the distribution of ages at death. This was based on the observation that  $r$  interacts with only one parameter of the Siler model ( $a_2$ ), and that in the distribution of ages at death,  $a_2$  occurs by itself and as  $a_2+r$ . However, the method has not been applied and concern remains that this approach may not be a reliable estimator. This paper examines the reliability of this approach using death data with known properties. Simulated data were generated uniformly across a range of expectations of life (30 years to 70) and values of  $r$  (0.0 % to 2.0%) and fitted using the Siler model incorporating  $r$ . The results indicate that this method is an unbiased estimator of both  $r$  ( $p=0.68$ ) and of expectation of life ( $p=.29$ ). The standard error of the estimate of  $r$  is 0.075% while the standard error of expectation of life is 0.36 years. These

results indicate that the method works well when the Siler model is the correct model and sample sizes are large. This method could eliminate one of the primary issues concerning demographic estimation with anthropological data. Examples with real data are presented.

This analysis was funded in part by NICHHD R24 HD044943

### Micro-fossils Recovered from Dental Calculus: Implications for Reconstructing Moche Diet

CELESTE MARIE. GAGNON<sup>1</sup> and ANN O. LAFFEY<sup>2</sup>

<sup>1</sup>Anthropology, Wagner College, <sup>2</sup>Anthropology, University of Florida

The Moche of north coastal Peru (AD 200-800) have been the focus of much archaeological investigation. Although analyses of settlement pattern, site layout and construction, and mortuary and ritual practice have shed light on social organization, little is known about Moche diets and thus the daily experience of political economy. To begin to address these questions, the remains of 115 individuals excavated from the Huacas de Moche site (the paramount center in the Moche Valley) were examined. This sample included 62 individuals excavated from tombs located in Huaca de la Luna and 53 individuals recovered from the urban core. Previously reported oral health indicators suggest that individuals buried in the urban core consumed more carbohydrates than those interred in the huaca. To further contextualize oral health data, dental calculus was collected from 20 individuals who presented deposits sufficient for sampling. Because calculus preserves micro-botanical remains such as phytoliths, pollen, sponge spicules, and starch grains, it can provide direct and proxy evidence of paleodiet. Samples were deflocculated, mounted, and micro-fossils were identified using polarized microscopy. The presence of Type 1 starch grains associated with grasses and collected plants was detected. Further, both spicules forms and distinctive tissues known as cornus anastomosis associated with two species of sponges: *Clathrina antofagastensis* and *Sycon huinayense*, were identified. These species are known to be associated with macroalgae and mussel species such as *Pyura chilensis*, thus their presence have paleodietary implications. These data suggest both field crops and marine resources were important components of Moche diets.

Research was supported by the Wagner College Faculty Research Grant and Anonymous Donor Grant and Student Support.

### Cranial and Mandibular Variation Preceding the Emergence of Agriculture in Eastern Europe and Western Asia

MANON GALLAND<sup>1</sup>, ANDREI GROMOV<sup>2</sup>, VYACHESLAV MOISEYEV<sup>2</sup>, SEGUEY VASILYEV<sup>2</sup>,

# ABSTRACTS

ELIZAVETA VESELOVSKAYA<sup>2</sup> and RON MI. PINHASI<sup>1</sup>

<sup>1</sup>School of Archaeology, University College Dublin, <sup>2</sup>Centre of physical anthropology, Institute Ethnology and Anthropology RAS, <sup>3</sup>Anthropology, Peter the Great Museum of Anthropology and Ethnography (Kunstkamera), Russian Academy of Sciences

The transition from hunting to farming was a key event in modern human history and evolution. The nature and timing of this major cultural shift varied across world regions. The extent to which changes in subsistence and lifestyle have impacted skull shape is currently unclear. Here we investigated craniofacial and mandibular variations in populations from Eastern Europe and Western Asia spanning from the Late Mesolithic to the Late Neolithic. Our aim is to assess the structure of morphological variability and to interpret it in relation to cultural and technological transitions. Our sample includes: (i) 70 specimens from three archaeological sites (Parkhai, Turkmenistan; Vasilevka, Ukraine; Zvejniecki, Latvia) where a cultural transition has been recorded; (ii) 70 specimens from various European and Western Asian archaeological sites and historical-period populations. All individuals were surface-scanned and then 33 and 39 standard three-dimensional landmarks were respectively extracted on skulls and mandibles and analysed applying geometric morphometrics methods. Both cranial and mandibular variations show a separation between Late Mesolithic/Early Neolithic from Late Neolithic/recent samples. However, cranial variation highly differs within each of the three archaeological sites: strong differentiation between cultural phases in Ukraine, slight differentiation in Turkmenistan to lack of differentiation between specimens from different periods in the case of Latvia suggesting an evolution in situ. By contrast, mandibular morphology does not reveal strong local differences, which is consistent with archaeological data indicating a continuation of hunter-gatherer lifestyle during Early/Middle Neolithic. This study highlights the complexity and region-specific variations in the Neolithization process on phenetic signal.

## Global Environmental Change: Effects on East African Pastoral Mobility and Biology

KATHLEEN GALVIN and TYLER BEETON  
Anthropology, Colorado State University

Pastoral peoples face new and accelerating political, economic, and climatic stresses that challenge their resilience and ability to adapt. As human populations and consumption grow, so does the pressure to convert wetter regions to towns, suburbs, and cropland. Mining, oil, and gas extraction and renewable energy production are spreading across the lands. Land scarcity often leads to subdivision of formerly intact communal land into fragmented private land, although some historically private lands are starting

to consolidate management across property boundaries. Climate change adds new challenges with warmer temperatures, changing rainfall, and increasing frequency of extreme events.

Pastoralists respond to these changes by adapting their livelihoods and creating new ways to manage rangelands through new rules and institutions. As economic demands grow for pastoral families, they diversify into new sources of income beyond livestock where possible and invest more into livestock to intensify production. There is an important and complex relationship between the environment, economic status, lifestyle and nutritional status. Accompanying these interacting variables is often a change in labor and work tasks with an increased reliance on purchased foods. This process is termed a nutrition transition. Are pastoralists making this change? Food security, as measured by nutritional status, in the savannas of east Africa has scarcely improved in the last 30 years. Data on weight, height, skinfolds, and circumferences were collected from 534 individuals in the year 2000 in southern Kenya. Results indicate that nutritional status is poor and has remained so despite numerous changes to the social-ecological system.

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## Investigating Pterion from Three Perspectives: Phylogeny, Biomechanics and Size

NAMBI J. GAMET and JOAN C. STEVENSON  
Anthropology, Western Washington University

Pterion is a skull landmark located directly behind the eye orbits where four cranial bones (sphenoid, parietal, temporal and frontal) articulate in 4 basic configurations: spheno-parietal (SP), fronto-temporal, stellate and epipteric. Few have studied the influences on this surgically important landmark. Three hypotheses may explain the configurations and other aspects of pterion: 1) phylogenetic history reflected in conservative (shared) development in species with shared ancestry; 2) biomechanical forces due partly to chewing stressors on skull shape; and 3) the influences of body size (allometry). These 3 hypothesized factors are tested here in a comparison of ecologically diverse mammal skulls.

Skulls from UW's Burke Museum were assessed for configurations, suture lengths (sides averaged), measures of cranium, and masseter and temporalis muscles during September 2015-April 2016 for: *Canis latrans* (n=30), *Vulpes vulpes* (30), *Ursus americanus* (30), *Puma concolor* (18), *Lynx rufus* (30), *Papio hamadryas* (8), *Saimiri sciureus* (8), *Odocoileus hemionus* (14), *Cervus elaphus* (4),

*Lepus americanus* (21). Chi square, t tests and regressions were run using SPSS 23.

There is evidence for all three hypotheses. Phylogenetic conservatism is supported by the lack of configurational diversity (e.g., virtually 100% SP in Carnivore species) within species up to order. By contrast, Montagu noted configurational diversity within and between Primate species which may be unusual. Biomechanics and size are important also because regressions of both size of mastication muscles or cranial size variables on sutural length explained from 70 to 85% of the variation.

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## The gut microbiome and metabolome of saddle-back tamarins (*Leontocebus weddelli*): Understanding the foraging ecology of a small-bodied primate

PAUL A. GARBER<sup>1</sup> and ANDRES GOMEZ<sup>2</sup>

<sup>1</sup>Anthropology, University of Illinois, Urbana, Illinois 61801, <sup>2</sup>Genomic Medicine and Human Biology, J. Craig Venter Institute, La Jolla, CA 92037

Body mass is a strong predictor of diet and nutritional requirements across a wide range of mammals. For example, due to their small gut volumes, rapid food passage rates and high metabolic rate, small-bodied primates are hypothesized to maintain high digestive efficiency by exploiting foods rich in protein and readily available energy. However, our understanding of dietary requirements is limited because, at the molecular level, little is known concerning the contributions of the gut microbiome to host nutrition. To study how food choice correlates with digestive efficiency in a small-bodied primate, we analyzed the gut microbiome and metabolome in fecal samples from 22 wild Bolivian saddle-back tamarins. Samples were analyzed using high-throughput Illumina sequencing of the 16S rRNA gene V3-V5 regions, coupled with GC-MS metabolomic profiling. Our analysis revealed that the distal microbiome of *L. weddelli* is largely dominated by *Xylanibacter* and *Hallella* (34.7±14.7 and 22.6 ±12.4% respectively), two taxa commonly associated with high carbohydrate fermentation rates. A predictive analysis of functions likely carried out by bacteria in the tamarin gut was consistent with carbohydrate uptake as the predominant metabolic pathway. Moreover, given a fecal metabolome composed mainly of glucose, fructose and lactic acid (21.7%±15.9, 16.5%±10.7 and 6.8% ±5.5 respectively), sugar fermentation appears to play a dominant role in the nutritional ecology of tamarins. Our results indicate high energetic turnover in the distal gut of *L. weddelli*, which is likely associated with their dietary dependence on highly digestible sugars present in nectar, plant exudates, and ripe fruits

# ABSTRACTS

*Funds to conduct this research were provided through the University of Illinois.*

## **Histological Age Estimation on two Mediterranean Populations: A Validation study of four Existing Methodologies**

JULIETA GARCÍA-DONAS<sup>1</sup>, A. R. SCHOLL<sup>1</sup>, A. DALTON<sup>1</sup>, R. R. PAINE<sup>2</sup> and E. F. KRANIOTI<sup>1</sup>

<sup>1</sup>Classics and Archaeology, Archaeology Department, University of Edinburgh, <sup>2</sup>Sociology & Anthropology, Texas Tech University

Age estimation is crucial for the identification of human remains and the microscopic approach is the only option when the remains are very fragmented. Many histological age estimation techniques have been developed in the last forty years and in order to ensure the accuracy and reliability of existing aging methods, validation studies must be carried out. In our study, we present the results obtained by applying four existing age estimation techniques using rib histomorphometry on two Mediterranean populations. The relationship between the histological variables and age as well as sex is examined, the age estimates are calculated and the error rates produced by these methods reported. All variables were found to be correlated to age except for osteon circularity whilst none of the variables used in this study was correlated to sex. For three of the techniques, the data shows a systemic underestimation of age for most of the specimens with an increased error rate for the oldest individuals. Only one of the aging methodologies produced overestimation of young specimens and more accurate estimates for the oldest specimens which is in accordance with the results reported by the original study. Our research suggests the possibility of inter-population variation in remodelling dynamics although a larger sample is needed to verify our preliminary results. We demonstrate that validation studies are required in order to choose the most adequate method, especially in forensic cases with legal implications.

## **Early Life Stress at the Mission Santa Catalina de Guale: Combining Enamel Defects and Incremental Isotope Analysis of Dentin to Explore Nutrition as a Source of Stress**

CAREY J. GARLAND and LAURIE J. REITSEMA  
Anthropology, University of Georgia

Spanish missionization in southeastern North America is associated with increased indigenous skeletal stress due to novel infectious diseases, population aggregation, and changes in diet, such as increased reliance on maize. However, diet should not simplistically be equated with nutrition. The present study examines internal enamel micro-defects and incremental isotopic data from tooth dentin to reconstruct early life stress

and dietary histories of Guale individuals interred at the Spanish mission of Santa Catalina de Guale (SCDG) (AD 1605-1680), located on Saint Catherines Island, GA. By comparing incremental isotopic data from tooth dentin with enamel defect records from individuals interred at the contextually rich SCDG, nutrition as a source of stress can be explored, especially early life stress associated with the transition from breast milk to solid foods. Results reveal high levels of early life stress at SCDG, with 93% of individuals (n=14) exhibiting at least one defect and an average of 4.6 defects per individual. Stress chronologies show that individuals experienced the highest frequency of stress events between the ages of two to three years, a time period associated with weaning. Carbon and nitrogen isotope data from incrementally sampled dentine of the same teeth test the hypothesis that dental micro-defects are associated with weaning onto a diet that emphasizes nutritionally poor maize. This study underscores the importance of combining stable isotope and paleopathology data to explore sources of non-specific stresses seen in skeletal assemblages, especially in providing a link between diet and nutritional stress.

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## **Comparison of body size changes among military personnel between 1988 and 2012**

TODD N. GARLIE, HYEONG JOO CHOI, JOESPH L. PARHAM, J. DAVID BRANTLEY and STEVEN P. PAQUETTE

Anthropology, US Army Natick Soldier Research, Development and Engineering Center (NSRDEC)

Understanding body size is important for the development and evaluation of workspaces and clothing and individual equipment (CIE) design. Nowhere is this more important than within the military, or other first responder populations, where such equipment provides critical lifesaving properties. The US military has undertaken a multitude of anthropometric surveys since the 1860's that have provided critical body dimensions to aid in the design and development of military products (White and Churchill, 1971; and Gordon et al., 1989). In 2006, the Army conducted a preliminary study (ANSUR II, pilot) that showed, in general, body size in the military population has changed since 1988 (Paquette et al., 2009). In 2012 the Army conducted a full scale anthropometry survey of Active Duty Soldiers, Army Reservists and Army National Guard in order to update the anthropometry of the US military and provide better data for design and development (Gordon et al., 2014). The goal of this paper is to provide a detailed comparative analysis of body size among military personnel between 1988 and 2012, specifically between different

population groups relative to the Department of Defense (DoD) race categories. Results indicate significant body size changes related to circumferential measurements while those measurements related to height and length have remained relatively unchanged in all population groups compared. Given these trends in body size increases, a theoretical evaluation of secular changes within population groups relative to accommodation rates required for clothing and equipment design in the US Army (i.e. 90%, 95%, or 98%) is recommended.

## **Mobility at Neolithic Çatalhöyük: Temporal and Ontogenetic Context**

EVAN M. GAROFALO<sup>1</sup>, CHRISTOPHER B. RUFF<sup>2</sup> and CLARK S. LARSEN<sup>3</sup>

<sup>1</sup>Basic Medical Science, University of Arizona College of Medicine - Phoenix, <sup>2</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>3</sup>Department of Anthropology, The Ohio State University

Neolithic inhabitants of Çatalhöyük (Turkey) likely became more mobile over ca 1400 years of continuous occupation as land and water resources became more scarce close to the settlement. Although children often participate in subsistence activities, temporal differences in ontogenetic behavior patterns and when they appear during growth have not been systematically tested in Çatalhöyük. Mobility is expected to increase in later occupations with divergence occurring later in childhood.

Temporal patterns were evaluated for growth in Çatalhöyük from stature (n=48) and body mass (n=44), derived from femoral length and femoral head or distal metaphyseal breadth, respectively. A ratio of AP and ML cross-sectional bending strength was calculated (Zx/Zy), determined at femoral midshaft, for each individual as a measure of mobility (n=55) reconstructed using bi-planar radiography and periosteal molds. Male and female adult values (n=33) provided growth end-points.

Results indicate there is no temporal effect on stature or body mass during growth, therefore differences cannot be related to body size. However, after 6 years old, late period exhibits higher Zx/Zy values (increased AP bending strength:  $\bar{x} \dots = 1.05$ ,  $p < 0.05$ ), while the middle period shows relatively more ML bending strength in Zx/Zy ratios ( $\bar{x} \dots = 0.97$ ,  $p < 0.05$ ). Analyses support the assumption that immature individuals may have traveled greater distances in the middle and later periods of occupation at Çatalhöyük. These behaviors emerged in later childhood, further supporting an environmental explanation, reflecting greater participation in subsistence activities. This analysis enriches the complex story of behavioral change and juvenile

## ABSTRACTS

activity at Çatalhöyük and in broader cultural contexts.

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### Evolution of the primate vomeronasal system: fossil evidence from the Fayum

EVA C. GARRETT<sup>1</sup>, LAUREN A. GONZALES<sup>2</sup>, E. C. KIRK<sup>3</sup> and ERIK R. SEIFFERT<sup>4</sup>

<sup>1</sup>Department of Anthropology, Boston University, <sup>2</sup>Department of Evolutionary Anthropology, Duke University, <sup>3</sup>Department of Anthropology, University of Texas at Austin, <sup>4</sup>Department of Cell and Neurobiology, University of Southern California

Extant primates vary dramatically in the presence and development of the vomeronasal system (VNS), which largely detects social pheromones and anti-predator chemosignals. While the strepsirrhine VNS resembles most mammals, haplorhines either have derived VNS traits with ambiguous effects on vomeronasal function, or have lost the system entirely. While a reduced reliance on vomeronasal olfaction in haplorhines is inferred, few studies have addressed VNS variation in extinct primates to examine the timing and context of the loss of this system. We have previously identified an osteological correlate of the vomeronasal organ, the vomeronasal groove (VNG), which allows us to implement a paleontological approach toward understanding primate VNS evolution. We investigated cranial material of fossil primates for the presence or absence of a VNG using microCT scans. The VNG was present in a broad temporal and taxonomic range of primate fossils, including plesiadapiforms, adapiforms, omomyoids, crown platyrrhines, stem anthropoids, and stem catarrhines. Notably the VNG persists as a relatively small gutter in the stem catarrhine *Aegyptopithecus zeuxis*, but is absent in advanced stem catarrhine *Saadanius hijazensis*, and the Miocene cercopithecoid *Victoriapithecus*. We estimate that VNG loss occurred between 30-28ma, based on our sample. These dates complement estimates for the accelerated rate of deleterious mutations, and loss of function, in the TRPC2 pheromone transduction gene in catarrhines between 40-25ma. Further exploration of the VNG in fossil primates will lead to a more thorough understanding of past sensory environments and their ultimate effects on sensory specializations of extant lineages.

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### Seasonal Differences in Accumulated Degree-days on the Rate of Human Decomposition

SHELBY L. GARZA and DANIEL J. WESCOTT  
Anthropology, Texas State University

If seasonality is not accounted for while trying to estimate time-since-death, the medicolegal investigator could potentially produce an incorrect post-mortem interval (PMI). Therefore, it is important to examine if there is seasonal variation in the accumulated degree-days (ADD) necessary for decomposition. For this experiment, 10 human remains were placed in an outdoor setting at the Forensic Anthropology Research Facility in San Marcos, TX. Five of the remains were placed during the winter (December 21 – March 19) and five were placed during the summer (June 20 – September 21). The winter and summer remains were pair-matched for body size. Each subject was placed in a supine position under a wire cage to prevent scavenging. A total body score (TBS) was calculated for each subject at approximately 100, 300, and 500 ADD. At 100 ADD, 60 percent of the subjects placed during the winter had a lower TBS compared to their counterparts placed in the summer. For 80 percent of the winter subjects, skin slippage and marbling did not even occur within 100 ADD. The TBS scores were significantly lower for all subjects placed during the winter compared to summer placements at 300 and 500 ADD. This research provides evidence that there is a significant difference in the rate of decomposition between seasons, even when using ADD. Therefore, determining the season of death is a necessary first step when using TBS to estimate the PMI.

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### Finding Etruscan Bones: Confocal Laser Scanning Microscope in archaeological context

LUCA GASPARI<sup>1</sup>, MAURIZIO SANNIBALE<sup>2</sup>, FLAVIO DE ANGELIS<sup>1</sup>, PAOLA CATALANO<sup>3</sup> and OLGA RICKARDS<sup>1</sup>

<sup>1</sup>Biology, University of Rome Tor Vergata, <sup>2</sup>Gregorian Etruscan Museum, Vatican Museums, 00120 Città del Vaticano, <sup>3</sup>Soprintendenza Speciale per il Colosseo, il Museo Nazionale Romano e l'area archeologica di Roma, Rome, Italy

Notwithstanding Etruscan tombs are well recognized because of their archaeological context, little is known about their anthropological framework. A bright example of this dichotomic landscape is provided by Regolini-Galassi tomb, one of the richest and most meaningful tumulus in Etruscan Etruria (675-650 BCE), where no bone remains were unequivocally identified at the time of discovery in 1836. Even though the absolutely precious goods suggested the presence of a princess, several historical and archaeological surveys did not be able to ascertain the presence of skeletons in the tumulus.

A recent prospection of a soil sample preserved at Gregorian Etruscan Museum in Vatican Museums allows us to consider an original evidence to be analyzed by dissecting microscope. Further analysis have been performed by Confocal Laser Scanning Microscope (CLSM) in

order to analyze the bone structure of the ancient sample because its ability to explore the bone tissue structure at different levels below the surface. Confocal Laser Scanning Microscope has been especially useful in providing information on the 3D paths of bone such as osteons and Haversian canals. The fragment points out a heterogeneous primary fluorescence at 635 nm highlighting the Haversian systems, that are the fundamental functional units of compact bone tissue.

The structure of the active osteons is clearly visible, with the concentric traces of the bone lamellae around the Haversian canals as suggested also by the laser profiles. The results support the specific microscopic approach as an helpful proxy for anthropological and archaeological research.

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### Hybridization and reticulation in hominin evolution

JOANNA R. GAUTNEY<sup>1,2</sup> and TRENTON W. HOLLIDAY<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of North Carolina at Chapel Hill, <sup>2</sup>Department of Anthropology, Tulane University

The phylogenetics of a relatively speciose period in hominin evolution (i.e., between ca. 3 Ma and 1 Ma) is explored. This is a period when several distinct yet closely related hominin species lived contemporaneously in overlapping regions of Africa. Usually, such phylogenetic relationships are investigated using phylogenetic analysis methods such as maximum parsimony. As a result, scholars have reconstructed hominin phylogenies from this period in terms of simple bifurcating tree-like relationships. While maximum parsimony is a useful analytical tool when investigating certain sets of taxa, it has shortcomings when applied to closely related species, especially if introgression and reticulation occurred between those species. This project investigated the possibility of reticulate relationships (rather than bifurcating tree-like relationships) among hominin taxa during this period by employing analytic methods more commonly used in evolutionary biology. Specifically, this study uses a previously published data set of characters from thirteen hominin paleospecies. The data are analyzed using maximum parsimony, the DELTRAN character optimization method, and a distance matrix method for examining the structure of the data and identifying sources of character conflict. Results indicate that conflicting signals in the data are consistent with more complexity than may be accounted for in tree-like interpretations. Just as Neandertals interbred with modern humans (and with the Denisovans), this study suggests that among early hominin taxa, phylogenetic relationships are more complex than have been previously proposed.

## ABSTRACTS

### Distal Phalanges and the Origin of Crown-Group Anthropoids

DAN GEBO<sup>1</sup>, MARIAN DAGOSTO<sup>2</sup>, CHRIS BEARD<sup>3</sup> and XIJUN NI<sup>4</sup>

<sup>1</sup>Department of Anthropology, Northern Illinois University, <sup>2</sup>Department of Cell and Molecular Biology, Northwestern University, <sup>3</sup>Department of Ecology & Evolutionary Biology, University of Kansas, <sup>4</sup>Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences

Hundreds of primate phalanges have been recovered from the Shanghuang fissure fillings from China. This sample includes proximal, middle and distal phalanges from the hand and foot including over three hundred nail bearing distal phalanges. For the distal phalanges, there are a variety of shapes, sizes, and types. Overall, there are five varieties of adapiform fossil primates at Shanghuang including a sample ( $n = 25$ ) of "grooming claws". Within the sample of Shanghuang haplorhines, eosimiids are extremely common with tarsii-forms, including *Macrotarsius*, tarsiids, and a crown anthropoid being far rarer. The origin of anthropoids, a topic near and dear to Professor Elwyn Simons, has had a long history of discovery and debate and this keystone evolutionary event separates primitive primates from the monkey and ape lineages. Paleontological and comparative anatomical work in the 1990s discovered eosimiids and clarified the initial stem lineage of anthropoids in Asia but the evolutionary connection to crown-group anthropoids, taxa with a close connection to living anthropoids, remains problematic and unresolved. Here we present a few new postcranial elements that document a crown-anthropoid in Asia at Shanghuang, China, 45 million years ago.

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### Female sooty mangabeys (*Cercocebus atys*) select softer seeds than males

ELISE GEISLER<sup>1</sup>, DAVID J. DAELING<sup>1</sup>, TAYLOR A. POLVADORE<sup>1</sup> and W. SCOTT MCGRAW<sup>2</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Anthropology, The Ohio State University

Much of the diet of *C. atys* consists of the oily nut of *Sacoglottis gabonensis* which is accessed by postcanine crushing of a hard protective coat. During a typical foraging bout, some nuts are discarded after initial crushing attempts; however, the reasons why individual nuts are rejected remain unclear. We examined hardness values of nuts rejected by adult male and female sooty mangabeys and compared these to an assemblage of random nuts on the forest floor. Our null hypothesis was that there is no significant difference in hardness between these groups.

We collected data on *C. atys* feeding on *S. gabonensis* in the Tai National Park, Cote d'Ivoire in

July-August, 2016. Nuts discarded by monkeys were collected and measured using type A and D durometers. We measured 104 nuts discarded by females and 79 discarded by males. The two largest values were averaged and compared employing nonparametric procedures. For both Shore A ( $P=0.0003$ ) and D ( $P=0.026$ ) hardness, discarded nuts differed significantly between sexes, with nuts discarded by females being harder than those of males.

Mean hardness of 69 nuts sampled randomly fell between the male and female values, but was not statistically different from hardness of nuts discarded by either sex. These results suggest that adult female but not adult male sooty mangabeys select nuts that are less mechanically challenging than the average. Thus, hardness does not appear to be the primary driving factor of food selection in male *C. atys*.

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### Human remains and vodou practitioners in northern Haiti: Ethics and research design in ethnoarchaeology

PAMELA L. GELLER

Anthropology, University of Miami

Here I suggest that bioarchaeologists who conduct projects in cultural settings with active descendant communities should make ethnographic interviews and participant observation the first phase of research design. To do so prior to excavation and analysis of human remains yields several productive outcomes. Research questions or issues for explorations are significantly broadened. Social inferences drawn from bioarchaeological data are enriched. Collaboration with local communities (or their disinclination to do so) engenders a bioarchaeological practice that is sociopolitically aware and ethically responsible.

As a case study, I discuss my ethnographic work in the northern Haitian community of Milot. The town is the location of the UNESCO World Heritage site Parc National Historique, comprised of Sans Souci Palace, Citadelle Laferrière, and Ramiers. Henri Christophe ordered his subjects to build these monumental structures after the Haitian Revolution (1791-1804), the only successful slave revolt in history. My work has explored the connection between Milot's patrimony and its residents, the majority of whose families have lived in the town for multiple generations. Interactions with community members have generated insights about the tangible and intangible dimensions of patrimony in northern Haiti, specifically the historic and contemporary use and significance of vodou religion and rituals, mortuary spaces, and human bones. This information has underscored the necessity of involving the descendant community in future bioarchaeological investigations focused on

slave villages, plantations, and their associated cemeteries.

### Sex-related Connectivity Differences in the LSCN

IAN D. GEORGE<sup>1</sup> and KRISTINA ALDRIDGE<sup>2</sup>

<sup>1</sup>Anatomical Sciences, Stony Brook University, <sup>2</sup>Pathology & Anatomical Sciences, University of Missouri School of Medicine

Sex-related differences in the human brain are a persistent topic of interest in studies of human behavior and evolution. However, studies of sexual dimorphism of brain morphology, activity, and their relationship with behavior present enormously conflicting findings, especially relating to language function. Our previous research of a sample of young adult males established connectivity of the language-specific cerebrocerebellar network (LSCN), a neural network connecting the left inferior frontal lobe to the right lateral cerebellum, which we subsequently determined to be strongly correlated with language ability. Here, we test the hypothesis that there are sex-related differences in the LSCN and its relationship to language.

Our sample included age-matched male ( $N=60$ ) and female subjects ( $N=7$ ). We quantified measures of connectivity in the LSCN using *in vivo* MRI and diffusion tensor imaging (DTI). We calculated correlation of these connectivity measures with language production using scores from the Clinical Evaluation of Language Fundamentals – 5<sup>th</sup> Edition (CELF5).

Our results show that connectivity measures of the LSCN do not differ significantly in males and females. Further, the LSCN measures are strongly correlated with language production ability in both male and female subjects. These preliminary results indicate that the LSCN is a key network in the human brain in both males and females for language production. Future investigation into connectivity of additional cortical areas hypothesized to be important in language is necessary to determine whether there are any sex-related language connectivity differences in the human brain.

*This research was funded by a Wenner-Gren Foundation Dissertation Fieldwork Grant, the University of Missouri Life Sciences Fellowship, the Pearson Research Assistance Program, and the University of Missouri Brain Imaging Center.*

### Ancestry estimation in Asian and Asian-derived populations using dental morphology

REBECCA L. GEORGE<sup>1</sup>, MARIN A. PILLOUD<sup>1</sup> and JORGE GÓMEZ-VALDÉS<sup>2</sup>

<sup>1</sup>Anthropology, University of Nevada, Reno, <sup>2</sup>Anatomy, Universidad Nacional Autónoma de México

## ABSTRACTS

The use of dental morphology to estimate ancestry has begun to grow within forensic anthropology, and several new methods have been published (e.g., Irish, 2015; Edgar, 2005, 2013). While these methods represent great advances, they are lacking in modern Asian reference samples. As such, they may be unable to adequately differentiate Asian individuals from those who express similar dental morphology (i.e., 'Hispanics,' and Native Americans). This study explores dental morphological population variation of various modern skeletal samples in an effort to improve methods of ancestry estimation.

Data were collected on Mexican skeletal collections housed at the Universidad Nacional Autónoma de México in Mexico City (n=90), Hispanic dental casts housed at the University of New Mexico in Albuquerque (n=71) (RLG), and a Japanese skeletal sample at Chiba University in Chiba, Japan (n=98) (MAP).

Univariate chi-square analyses indicate significant differences in almost all recorded traits. A mean measure of divergence (MMD) analysis demonstrates that the Mexican and Albuquerque Hispanic samples are more similar to each other than to the Japanese sample. However, when comparative published data from Hanihara (1998) are included, a multidimensional scaling plot of the MMD matrix shows that the Hispanic, Mexican, and Japanese samples cluster, although, the Hispanic data are intermediate between the Mexican, European, and West African samples. These results highlight the complexity of distinguishing between Asian and Asian-derived populations in methods relying on dental morphology, and underscore the need for large, modern reference samples in method creation.

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### Data standardization in anthropology: methods and best practice

NICOLE L. GESKE<sup>1</sup> and ASHLEY E. KENDELL<sup>2</sup>

<sup>1</sup>Anthropology, Michigan State University,

<sup>2</sup>Anthropology, University of Montana

With the passage of burial repatriation laws, standardization of osteological data in the United States became imperative, ultimately leading to the development of *Standards for Data Collection from Human Skeletal Remains (Standards)*. The impetus for data standardization stemmed not only from the need to collect data on remains that were soon to be returned, but also to ensure that data could be useful for future researchers. Now, over twenty years after the creation and adoption of *Standards*, these same methodologies are still considered current practice; however, difficulties in data collection and recordation remain.

Through the examination of data collection forms, notes, and protocols at institutions across the Midwest, variations in data collection, and

recordation in particular, were documented. Although each institution was relatively standardized in their method of data collection and recordation, inter-agency variations were apparent. This ultimately leads to a general lack of comparability of data sets across institutions, inhibiting bioarchaeological and osteological research.

The aim of this paper is to highlight the difficulties associated with standardized osteological data collection and recordation, localize weaknesses in current data recordation techniques, and to offer suggestions and recommendations for future improvement. Specifically, this paper aims to address our current standardization system for both data collection and recordation in order to ensure future osteological and bioarchaeological research.

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### Revised Transition Analysis: Validation on a Historical Sample and the First Archaeological Application of the New Procedure

SARA M. GETZ<sup>1</sup>, GEORGE R. MILNER<sup>1</sup> and JESPER L. BOLDSSEN<sup>2</sup>

<sup>1</sup>Anthropology, The Pennsylvania State University,

<sup>2</sup>ADBOU, Institute of Forensic Medicine, University of Southern Denmark

Although assessments of urbanization in Denmark, and for much of Europe, between the late middle ages and early modern period emphasize demographic shifts, these changes have little archaeological support. In conjunction with a research team, an age-estimation method has been developed using a reference sample of over 1,000 North American individuals. Forty features throughout the skeleton are analyzed in a Transition Analysis (TA) framework.

A test of the new procedure on a known-age historical sample (St. Bride's crypt, N=170) demonstrates that age estimates can be generated for the entire adult lifespan without significant bias. The method was then applied to two samples from the Danish city of Horsens – Ole Worms Gade (ca. 1350-1536 CE) and Monastery Church (ca. 1536 and 1856 CE) – along with four commonly used pubic symphysis and auricular surface methods and existing TA. Because the new TA procedure does not rely on information from the cranial sutures, sternal ribs, or pelvic joints, between 70 and 150 additional individuals in the archaeological sample were evaluated who could not be aged using traditional techniques. Although precision is influenced by the specific combination of features used, approximately 20 features are typically needed to produce reasonably precise age estimates.

Mortality distributions based on age estimates from each technique are compared to what would be expected from historic Danish parish records. This work provides a preliminary assessment

of the extent to which important archaeological data is currently being masked by age-estimation error.

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### Anthropological evidence of multi-ethnicity in the first Greek settlement in Italy. Strontium isotopic analysis of the skeletal sample from the necropolis of Pithekoussai, (Ischia VIII cent. BCE - III cent. CE)

MELANIA GIGANTE<sup>1</sup>, VIOLA WARTER<sup>2</sup>, WOLFGANG MÜLLER<sup>2</sup>, ALESSANDRA SPERDUTI<sup>1,3</sup> and LUCA BONDIOLI<sup>1</sup>

<sup>1</sup>Bioarcheologia - Museo Preistorico Etnografico Luigi Pigorini, Museo delle Civiltà - Roma, <sup>2</sup>Department of Earth Sciences, Royal Holloway University of London, <sup>3</sup>Dipartimento di Asia, Africa e Mediterraneo, Università degli studi di Napoli "L'Orientale"

The historical and archaeological record identifies Pithekoussai (island of Ischia, Italy, VIII cent. BCE - III cent. CE) as the first Greek settlement in Italy (Strabo *Geographia* V,4,9), afterwards followed by more extensive Greek migrations characterizing the rise of *Magna Graecia*. The most striking evidence is the so called *Coppa di Nestore*, which exhibits the most ancient Greek Euboan inscription so far known.

The Pithekoussai graveyard yielded more than 900 graves, both inhumations and cremations. The funerary record suggests a complex settlement history where Greek and Phoenician immigrants interacted with the local population. The peculiarity of the grave goods and the diverse treatment of the bodies are possibly referable to the origin and/or the social status of the deceased.

The aim of this study is to test the multi-ethnicity of Pithekoussai's community through the anthropological and isotopic analysis, mainly by the <sup>87</sup>Sr/<sup>86</sup>Sr ratio analysis performed on dental enamel (inhumated individuals) and the *pars petrosa* of the temporal bone (cremated and inhumated individuals). Fifty individuals, from the so-called Pithekoussai II series, have been analysed so far. The <sup>87</sup>Sr/<sup>86</sup>Sr ratio isotopic signal in the human mineralized tissues was compared to the local isotopic ratios derived from the analysis a. of the enamel of small modern mammals; b. of modern grass samples; and c. from the local volcanic bedrock signal known in literature.

Results confirm the presence of individuals born elsewhere (~ 22%), all adults, reinforcing the idea that Pithekoussai was a multi-ethnic community.

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### New fossil primates from the Lower Siwaliks of India

CHRISTOPHER C. GILBERT<sup>1,2,3</sup>, BIREN A. PATEL<sup>4,5</sup>, N. P. SINGH<sup>6</sup>, CHRISTOPHER J. CAMPISANO<sup>7,8</sup>, JOHN

## ABSTRACTS

G. FLEAGLE<sup>9</sup>, KATHLEEN L. RUST<sup>1</sup>, KELSEY D. PUGH<sup>2,3</sup> and RAJEEV PATNAIK<sup>6</sup>

<sup>1</sup>Department of Anthropology, Hunter College, CUNY, <sup>2</sup>PhD Program in Anthropology, The Graduate Center, CUNY, <sup>3</sup>New York Consortium in Evolutionary Primatology, (NYCEP), <sup>4</sup>Department of Cell and Neurobiology, Keck School of Medicine, University of Southern California, <sup>5</sup>Human and Evolutionary Biology Section, Department of Biological Sciences, University of Southern California, <sup>6</sup>Department of Geology, Panjab University, <sup>7</sup>School of Evolution and Social Change, Arizona State University, <sup>8</sup>Institute of Human Origins, Arizona State University, <sup>9</sup>Department of Anatomical Sciences, Stony Brook University

More than a century of collecting has yielded a large number of vertebrate fossils from Lower Siwalik deposits surrounding the town of Ramnagar, India. These include several specimens attributed to the hominoid *Sivapithecus*, and a single mandibular fragment of the adapoid *Sivaladapis palaeindicus*. In 2010, we renewed paleontological fieldwork at Ramnagar to better understand the geological, biogeographic, and paleoclimatic context of primate evolution in Asia. To date, we have identified new fossil localities with characteristic Chinji-aged fauna, tentatively dated between 11-14 Ma. In 2014, we recovered a sivaladapid primate from the site of Sunetar, and in 2015 a non-cercopithecoïd catarrhine primate was found at the same site. The sivaladapid is represented by a mandibular fragment with worn dentition and the catarrhine is known from an isolated M<sub>3</sub>. In this study, we present the results of comparative phenetic and cladistic analyses of these new primates. The Sunetar sivaladapid shares derived morphology with other Miocene sivaladapids (elongated P<sub>4</sub>, thin enamel, twinned entoconids-hypoconulids, open trigonids, deep lingual notches), but it is also distinct due to its combination of smaller size, relatively long molars, compressed trigonids, and weak cingulids. Phenetic analyses and a 40-character cladistic analysis support our attribution of this specimen to a new genus and species. The catarrhine tooth comes from a small-to-medium sized animal with morphology distinct from the large-bodied *Sivapithecus*. Anatomical comparisons indicate that this specimen is not aligned with pliopithecoids. The Sunetar catarrhine may represent an additional, and perhaps underappreciated primate radiation in Asia during the Middle Miocene.

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### BRAAAAINS!!! Chimpanzees at Gombe Consume Monkeys Head-First

IAN C. GILBY<sup>1</sup> and DANIEL WAWRZYNIAK<sup>2</sup>

<sup>1</sup>School of Human Evolution & Social Change, and Institute of Human Origins, Arizona State University, <sup>2</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University

Although chimpanzees (*Pan troglodytes*) primarily eat ripe fruit and vegetative matter, they also consume vertebrate prey. Despite considerable research on patterns of hunting and meat sharing in this species, relatively little is known about the nutritional benefits of eating meat for chimpanzees. While meat is undoubtedly a concentrated source of protein, fat, vitamins and micronutrients, these valuable molecules and elements are not distributed evenly throughout a carcass. For example, the brain is particularly rich in polyunsaturated fats, while the liver has high levels of vitamin A, iron and zinc. Documentation of the sequence in which chimpanzees consume different parts of a carcass will indicate which nutritional components they value most, and will therefore provide clues about the benefits of hunting. We videotaped meat-eating bouts by male chimpanzees at Gombe National Park, Tanzania. In 26 cases (7 males), we were able to ascertain which general body part the meat possessor began to eat first. A Generalized Linear Mixed Model indicated that the head was significantly more likely to be targeted first (69% of bouts) than either the torso (12%,  $Z = 3.4$ ,  $P < 0.0006$ ) or an appendage (19%,  $Z = 3.8$ ,  $P < 0.0001$ ). Age of the prey did not contribute significantly to the model. These preliminary analyses indicate that chimpanzees value the brain more highly than components of the torso (including viscera) or skeletal muscle. We hypothesize that this is due to the brain's relatively high fat content, which likely also motivated early hominins to seek vertebrate prey.

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### Associations between testosterone levels and parasite load: Testing life history tradeoffs among indigenous Shuar men from Amazonian Ecuador

THERESA E. GILDNER<sup>1</sup>, MELISSA A. LIEBERT<sup>1</sup>, TARA J. CEPON-ROBINS<sup>2</sup>, RICHARD G. BRIBIESCAS<sup>3</sup>, SAMUEL S. URLACHER<sup>4</sup>, JOSHUA M. SHROCK<sup>1</sup>, CHRISTOPHER J. HARRINGTON<sup>1</sup>, FELICIA C. MADIMENOS<sup>5</sup>, LAWRENCE S. SUGIYAMA<sup>1</sup> and J. JOSH SNODGRASS<sup>1</sup>

<sup>1</sup>Anthropology, University of Oregon, <sup>2</sup>Anthropology, University of Colorado, Colorado Springs, <sup>3</sup>Anthropology, Yale University, <sup>4</sup>Anthropology, Hunter College (CUNY), <sup>5</sup>Anthropology, Queens College (CUNY)

The hormone testosterone (T) is linked to male mating effort but believed to have immunosuppressive effects. Non-human animal models and some human studies have supported this relationship, and there is evidence that high T levels downregulate aspects of the immune system. We hypothesize that more immunocompetent males are better able to withstand health insults, facilitating the maintenance of high T levels. High T males should therefore exhibit lower average parasite loads, allowing continued energetic investment in mating effort over immune function. Few studies have tested this predicted relationship in natural fertility, subsistence-based populations with high pathogen risk. The present study provides a preliminary examination of the association between T profile and parasite load among indigenous Ecuadorian Shuar. One morning and one evening saliva sample were collected over three consecutive days to capture diurnal T patterns; salivary T levels were averaged to provide mean morning and evening T levels. A single stool sample was concomitantly collected from participants. Kato-Katz thick smears made from fresh stool samples were examined for standardized counts of helminth eggs per gram. In total, 72 Shuar men provided both saliva and stool samples (ages 14-67). Linear regressions controlling for factors associated with T levels (e.g., age, BMI, marital status, number of children) and parasite infection risk (household characteristics) were performed to examine the association between average morning or evening T levels and parasite load. This study provides important insights into human life history tradeoffs and makes a significant contribution to our understanding of male reproduction and health.

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### Roving Romans: Biomechanical and Fracture Evidence for Sex-related, Intensified Mobility at Vagnari, Italy

REBECCA J. GILMOUR<sup>1</sup>, TRACY L. PROWSE<sup>1</sup>, ERIK JURRIANS<sup>2</sup> and MEGAN B. BRICKLEY<sup>1</sup>

<sup>1</sup>Department of Anthropology, McMaster University, <sup>2</sup>Department of Radiology, Juravinski Hospital

Skeletal trauma and cross-sectional evidence for physical activity were assessed in the limb bones of 1<sup>st</sup> to 4<sup>th</sup> century AD Roman adults from the site of Vagnari, Italy (n=66). Vagnari was an Imperial estate with archaeological evidence that agriculture, viticulture, and transhumance were important economic activities. Manual labor associated with this lifestyle suggests that Vagnari residents likely experienced strain and injury associated with physical activity.

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Males at Vagnari have tibial areas that are larger than other reported tibial cross-sections, indicating that they engaged in relatively intense physical mobility. Additionally, of the fractures identified in females (n=3/28, 10.7%) and males (n=8/29, 27.6%), Vagnari males have fracture prevalence rates that are greater than at other Roman sites. In particular, indirect fractures consistent with slips, trips, falls, and overuse are common among Vagnari males (n=5/29, 17.2%). Leg bone fractures are especially noteworthy, and include a tibial stress fracture usually caused by repetitive strain. Vagnari females display no indirect fracture types and have tibial areas similar to those at other sites.

Cross-sections and fractures at Vagnari indicate that males were more intensely mobile and probably encountered greater fracture hazards associated with movement than females. Intensified movement related to transhumance, thought to have been important at Vagnari and typically a male undertaking in the Roman world, provides one possible explanation for the biomechanical and fracture evidence present among the males in this assemblage.

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### Combining 3DGM analyses from multiple anatomical regions improves phylogenetic interpretations of phenetic data in *Platyrrhini*

JUSTIN T. GLADMAN<sup>1,2</sup>, GABRIEL S. YAPUNCICH<sup>3</sup> and SIOBHAN B. COOKE<sup>4</sup>

<sup>1</sup>Department of Anthropology, The Graduate Center, CUNY; <sup>2</sup>New York Consortium in Evolutionary Primatology, NYCEP; <sup>3</sup>Department of Evolutionary Anthropology, Duke University; <sup>4</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

Three-dimensional geometric morphometrics (3DGM) has become a standard method for describing and analyzing shape variation in the primate skeleton. One promising application of 3DGM is the production of phenetic dendrograms in order to examine patterns of shared morphology and potentially shared evolutionary history. However, because 3DGM is often applied only to isolated anatomical regions, phenetic dendrograms may reflect functional convergence or homoplasy in these anatomical regions rather than phylogenetic relationships between taxa.

Here, we generate and compare several phenetic dendrograms from 3D landmark data aligned using generalized Procrustes analysis. Landmarks were placed on postcranial and dental elements (astragalus, calcaneus, humerus, ulna, and the lower second molar) representing a broad platyrrhine sample. To determine if

combining phenetic analyses from multiple anatomical regions recovers more accurate phylogenetic relationships, we concatenated the covariance matrices of all individual elements. We then compared the dendrograms from the individual and combined analyses to each other and an independent molecular phylogeny using two different tree comparison methods. According to both methods, combining phenetic data from all skeletal elements generated dendrograms that were 23-42% more similar to the molecular phylogeny. This increase in similarity occurred both at internal nodes deep in the tree (reflecting higher level phylogenetic relationships) and nodes near the tips (reflecting more accurate identification of sister taxa).

Our results suggest that the confounding effects of functional convergence and homoplasy, both potential pitfalls of phenetic analyses, may be mediated by increasing sampling across multiple anatomical regions.

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### Ethnic diversity in a 19<sup>th</sup> Century Colorado Insane Asylum: what the teeth tell us

ELLIOT HUBBARD, F. NUR ERBIL, MICHELLE GLANTZ and ANN MAGENNIS

Department of Anthropology, Colorado State University

Discrete dental morphological variation can facilitate hypothesis testing concerned with population structure and dynamics. For example, a few discrete dental traits may predict specific ethnicities; 27% of individuals of European descent exhibit Carabelli's trait above Grade 5 (ASUDAS) and 80% of individuals from the Americas exhibit shovel shaped incisors. This study compares the ethnic make-up of the 19<sup>th</sup> Century Colorado Insane Asylum taken from medical records and extrapolated from place of birth (or nativity) to an analysis of the frequencies of discrete dental traits from a sample of skeletons from the same institution (n=123). While medical records are not matched to individual skeletons, a comparison of results compiled from the hospital's archives with those from the dental study can be made. We assume tight correspondence between the archival data and that from the dental study. In agreement with archival records, results indicate that the majority of individuals from the skeletal sample are of European descent. However, the presence of a few discrete dental traits like cusp 7, incisal shovel shaping, and the canine mesial ridge indicates a more complex ethnic structure than reported in the records. Race in late 19<sup>th</sup> century Colorado and the politics embedded in the social context of mental institutions and their patients are discussed.

### The Effect of Mobility Impairment on Femoral Trabecular and Cortical Bone Structure

DEVORA S. GLEIBER and DANIEL J. WESCOTT

Department of Anthropology, Forensic Anthropology Center at Texas State, Texas State University

Reduced mobility or long-term immobility results in diminished muscular stress and normal weight bearing on the lower limb bones. Since mechanical usage influences trabecular architecture and cortical density, reduced ambulatory ability should be reflected in the trabecular structure and cortical area of the proximal femur. In this study, the proximal femur of mobility-impaired and normal mobility individuals was assessed for differences in trabecular architecture and cortical area. High-resolution computed tomography was used to scan the femora of ten mobility-impaired and ten age and sex matched normal mobility individuals. A cubic volume of interest (VOI) was extracted from the center of each femoral head. Bone volume fraction, connectivity density, degree of anisotropy, structure model index, and trabecular thickness and separation were calculated for each VOI. Two-tailed t-tests show that mobility-impaired individuals have significantly less bone volume fraction, connectivity density, and anisotropy, and greater trabecular separation than normal mobility individuals. Additionally, cross-sectional slices of the cortical bone at midpoint of the femoral neck, subtrochanteric, and midshaft of the femur show that mobility-impaired individuals have less cortical area in all directions than do normal mobility individuals. The results of this study suggest that the lack of biomechanical burden on mobility-impaired individual femora is reflected in their trabecular structure and cortical bone.

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### The Ontogeny of Masticatory Efficiency and Implications for Hominin Canine Reduction

HALSZKA GLOWACKA and GARY T. SCHWARTZ

Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University

According to the Masticatory Efficiency Hypothesis, the anthropoid masticatory system represents a compromise among optimizing canine size, gape, and efficiency. If large canines come at a cost to the efficiency of the system, this cost should occur after permanent canine eruption. We investigated whether anthropoids experience a decrease in masticatory efficiency during ontogeny. We collected 3D landmark data on relevant aspects of the bony masticatory system in infants and adults of 17 anthropoid species. These data were used to calculate efficiency via masseter leverage at the last molar

## ABSTRACTS

and canine. We used Mann-Whitney *U* tests to compare leverage between infant and adult conspecifics. Infants of 13 species had significantly less leverage than adults at both bite points suggesting that eruption of permanent canines in most anthropoids does not decrease masticatory efficiency. Only the derived masticatory system of papionins yielded support for the hypothesis. This group, which possesses the tallest canines, exhibited no significant differences between infants and adults in leverage at the last molar, but adults had significantly less leverage at the canine than infants. The hypothesis predicts that early hominin masticatory system configuration may result from selection for increased bite forces, facilitated by a reduction in gape and canine height. Yet, one of the earliest hominins, *Ardipithecus ramidus*, possessed reduced canines but lacked adaptations associated with increased bite force. Our results suggest that canine height reduction could have occurred in the hominin lineage without a necessary increase in masticatory efficiency, a possibility supported by the morphology of *A. ramidus*.

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### Building an osteological reference collection of modern Filipino individuals

MATTHEW C. GO<sup>1</sup>, AMANDA B. LEE<sup>1</sup> and REBECCA CROZIER<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>Archaeological Studies Program, University of the Philippines

In response to the need for diversified skeletal research materials, 75 modern Filipino skeletons, most with known age and sex, have been accessioned into a reference collection at the Archaeological Studies Program, University of the Philippines, Diliman, Philippines. The current sample size reflects a two-month effort during the 2016 summer season, with the addition of more individuals expected to follow in succeeding years. Individuals come from abandoned and subsequently exhumed leased niche tombs at Manila North Cemetery, wherein the tombstone is kept associated with the remains for an undefined period of time before being buried in a mass grave. These remains were instead salvaged for study. This paper describes the source site, curatorial methods, demographic composition, and research implications of the collection. All individuals lived during the 20th to 21st centuries, and represent known ages-at-death ranging from 15 to 88 years old. The number of males is nearly twice the number of females. Commingled and fragmentary remains were also accessioned for teaching purposes. The addition of the Philippines to a growing number of reference

collections around the world enhances investigative capacity in the fields of forensics, evolution, medicine, and skeletal biology, especially for this understudied yet vital population and region. The project also represents a mutually beneficial endeavor between researchers, cemetery administration, and local stakeholders.

*Funding for the collection was provided by the UIUC Department of Anthropology and the Social Sciences and Humanities Research Council of Canada (Award Number 752-2016-0221).*

### Cortical Thickness as a Supplement to Osteon Population Density to Estimate Age at Death

TIMOTHY P. GOCHA<sup>1,2</sup>, MICHELLE M. MURACH<sup>1</sup> and AMANDA M. AGNEW<sup>1,3</sup>

<sup>1</sup>Skeletal Biology Research Lab, The Ohio State University, <sup>2</sup>Forensic Anthropology Center, Texas State University, <sup>3</sup>Department of Anthropology, The Ohio State University

Osteon population density (OPD) in cortical bone is known to be useful in estimating age at death. Cortical thickness has also been investigated though it has been met with varied results, and prior research has measured this manually, sometimes arbitrarily. Previous research from our lab demonstrated that when the femoral cortex was divided circumferentially into anterior, posterior, medial, and lateral quadrants, and radially into periosteal, middle, and endosteal thirds, a combination of the periosteal and middle thirds from the anterior and lateral quadrants produced the most accurate prediction model for estimating age at death (adjusted  $R^2=0.907$ ,  $p<0.000$ ). This current research sought to examine cortical thickness, measured objectively, in the quadrants of the femur to see if their inclusion would increase the accuracy of estimating age at death.

Thirty complete cross-sections from modern cadaveric femora were used, 15 of each sex, ranging from 21–97 years. A custom MATLAB code was written to evaluate cortical thickness by measuring a series of lines between + 10% of the quadrant center, from the periosteal to endosteal border, each perpendicular to a tangent line based on a periosteal node.

Measurements of cortical thickness from the anterior and lateral quadrants did not significantly correlate with age at death, though normalized by total subperiosteal area, anterior cortical thickness did significantly correlate with age. Combining anterior cortical thickness with OPD from the regions mentioned above, neither increased nor decreased the predictive ability of the regression function (adjusted  $R^2=0.907$ ,  $p<0.000$ ) to estimate age at death.

### Neolithic familial migration contrasts Bronze Age male migration inferred from ancient X chromosomes

AMY GOLDBERG<sup>1</sup>, TORSTEN GUNTER<sup>2</sup>, NOAH A. ROSENBERG<sup>1</sup> and MATTIAS JAKOBSSON<sup>2</sup>

<sup>1</sup>Biology Department, Stanford University, <sup>2</sup>Department of Organismal Biology, Uppsala University

Dramatic events in human prehistory, such as the spread of agriculture to Europe from Anatolia and the Late Neolithic/Bronze Age (LNBA) migration from the Pontic-Caspian steppe, can be investigated using patterns of genetic variation among the people that lived in those times. In particular, studies of differing female and male demographic histories on the basis of ancient genomes can provide information about complexities of social structures and cultural interactions in prehistoric populations. We use a mechanistic admixture model to compare the sex-specifically-inherited X chromosome to the autosomes in 20 early Neolithic and 16 LNBA human remains. Contrary to previous hypotheses suggested by the patrilocality of many agricultural population, we find no evidence of sex-biased admixture during the migration that spread farming across Europe during the early Neolithic. For later migrations from the Pontic steppe during the LNBA, however, we estimate a dramatic male bias, with ~10-25 migrating males for every migrating female. We find evidence of ongoing, primarily male, migration from the steppe to central Europe over a period of multiple generations, with a level of sex bias that excludes a pulse migration during a single generation. The contrasting patterns of sex-specific migration during these two migrations suggest a view of differing cultural histories in which the Neolithic transition was driven by mass migration of both males and females in roughly equal numbers, perhaps whole families, whereas the later Bronze Age migration and cultural shift were instead driven by male migration, potentially connected to new technology and conquest.

### Meta-OMIC Reconstruction of Host-microbe Interactions in the Primate Gut: Implications for Human Origins

ANDRES GOMEZ<sup>1</sup> and KLARA PETRZELKOVA<sup>2</sup>

<sup>1</sup>Departments of Human Biology and Genomic Medicine, J. Craig Venter Institute, <sup>2</sup>Institute of Vertebrate Biology, Czech Academy of Sciences

The concept of the holobiont, which considers both host and symbiotic microbes as a single unit for selection in evolution, suggests that the evolution process cannot be fully understood without considering the role that residing microbes play in the physiological landscape of the host. Here, I show how -in addition to the behavioral, morphological, fossil and host-genomic data that have built our understanding of human origins- an extensive molecular analysis of the primate gut

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microbiome offers a complementary view of the extrinsic and intrinsic forces that triggered human evolution. To that end I use integrated Meta-OMICS; merging metagenomic, metabolomic and metatranscriptomics data from stool samples to reconstruct the organizational and functional complexity of the gut microecosystem of wild *Gorilla* spp., *Pan* and Central African hunter-gatherers, from an evolutionary standpoint. In addition, I use this comparative framework to assess the potential impact that the gut microbiome has exerted in the gene regulatory landscape of the human and non-human primate gastrointestinal tract. In synthesis, these data sheds light on how, over evolutionary timescales, diet and gut microbes could have intersected to influence energy harvest and immunity, impacting the emergence of the lineage leading to humans.

### The vertebral column of the Gran Dolina-TD6 and Sima de los Huesos hominins: new remains and new results

ASIER GÓMEZ-OLIVENCIA<sup>1,2,3</sup>, JUAN LUIS ARSUAGA<sup>3,4</sup>, JOSÉ MARÍA BERMÚDEZ DE CASTRO<sup>5,6</sup> and EUDALD CARBONELL<sup>7,8</sup>

<sup>1</sup>Dept. of Stratigraphy and Paleontology, University of the Basque Country, Leioa, Spain, <sup>2</sup>Ikerbasque, Basque Foundation for Science, Bilbao, Spain., <sup>3</sup>Centro Mixto UCM-ISCI de Evolución, Madrid, Spain, <sup>4</sup>Dpto. de Paleontología, Universidad Complutense de Madrid, Madrid, Spain, <sup>5</sup>Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain, <sup>6</sup>University College London, London, UK, <sup>7</sup>Institut Català de Paleoeologia Humana i Evolució Social (IPHES), Tarragona, Spain, <sup>8</sup>Àrea de Prehistòria, Departament d'Història i Historia de l'Art, Universitat Rovira i Virgili (URV), Tarragona, Spain

The Early Pleistocene Gran Dolina-TD6 and the Middle Pleistocene Sima de los Huesos (SH) sites in Atapuerca (Burgos, Spain) provide a unique fossil record of the vertebral column in genus *Homo*. In this paper we present vertebral remains from Gran Dolina-TD6, which comprise nine new elements and provide a general account of the spinal morphology of the SH populations and its evolutionary implications.

In Gran Dolina-TD6 there are 16 vertebral fossil remains representing all anatomical regions: six cervical, six thoracic, one thoracic or lumbar and three lumbar remains), which represent a minimum of five individuals. These vertebral remains are mostly fragmentary as they have been cannibalized and most complete vertebral specimen is an adult sixth cervical vertebra which shows a very horizontal spinous process, a feature also present in the KNM-WT 15,000 C7, and which has been proposed as primitive feature.

In SH, there is a minimum of 212 vertebrae preserved belonging to a minimum of 12 individuals. The spine of this population is

morphologically different from both modern humans and Neandertals. The spine of the SH population shows some derived features present in Neandertals, like a reduced lumbar lordosis but also retains some primitive features like a dorso-lateral orientation (in cranial view) of the transverse process of the lumbar vertebrae, which is derived (lateral) in Neandertals. Thus, the spine of the SH population does not display the full suite of derived Neandertal features, a pattern also present in the cranium and the rest of the postcranium.

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### The evolution of human altriciality and brain plasticity in comparative context

AIDA GÓMEZ-ROBLES<sup>1</sup>, JEROEN B. SMAERS<sup>2</sup> and CHET C. SHERWOOD<sup>1</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>2</sup>Department of Anthropology, Stony Brook University

Recent analyses have shown that human brains are substantially more plastic than chimpanzee brains. Increased brain plasticity evolved in hominins concomitant with a secondary altricial pattern of development, but a broad comparative context can provide additional insight to infer more detailed patterns of brain development in hominins. We first measured lineage-specific rates of the evolution of altriciality across a sample of more than 30 primate species using the ratio of neonatal to adult brain size, a variable that has been associated with behavioral altriciality. Our analyses show that evolutionary rates for neonatal/adult brain size ratio in hominoids are similar to those observed for adult brain size. However, altriciality evolved at similar rates in the branch antedating the origin of great apes and in the human branch, whereas adult brain size evolved substantially faster in the former. Second, we used published developmental models obtained from a diverse sample of mammals to infer patterns of brain development in fossil hominin species. Using known adult brain sizes (as inferred from endocranial capacity) and a range of possible gestation lengths for *Australopithecus*, *Paranthropus* and *Homo* species, we infer that some aspects of rapid synaptogenesis in the cerebral cortex and myelination of limbic, striatal and cortical structures were shifted more postnatally and under complex environmental influences after hominins surpassed a brain size of 900-1000 grams. This indicates that aspects of neurodevelopmental altriciality and plasticity observed in modern humans may have been shared by *Homo erectus* and other late *Homo* species.

This work was supported by National Institutes of Health grant NS042867 and James S. McDonnell Foundation grant 220020293.

### Documenting Skeletal Anatomy of Early Adapiforms

LAUREN A. GONZALES<sup>1</sup>, CALLIE H. CRAWFORD<sup>2</sup>, JUSTIN T. GLADMAN<sup>3</sup>, JOHN P. ALEXANDER<sup>4</sup>, JONATHAN I. BLOCH<sup>5</sup>, GREGG F. GUNNELL<sup>1</sup> and DOUG M. BOYER<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Department of Biology, New Jersey Institute of Technology, <sup>3</sup>Shared Materials Instrumentation Facility (SMIF), Duke University, <sup>4</sup>Burke Museum, University of Washington, <sup>5</sup>Florida Museum of Natural History, University of Florida

Though notharctine adapiforms are some of the most abundantly and completely preserved early primates, study of their anatomy has been limited by the difficulty involved in accessing, identifying and measuring fossil specimens consisting of scores of delicate bones that have to be carefully handled to prevent breakage or loss of provenance. Without direct access, it is often unclear which parts of many classically referenced specimens were reconstructed and which parts of the anatomy are actually known. In order to improve the potential for studying these early euprimates, we have microCT and white-light scanned key specimens from collections at the Smithsonian (NMNH), the American Museum of Natural History (AMNH) and several other institutions, and have organized these 3D datasets into a virtual collection that will be made openly accessible through the web archive MorphoSource. So far, we have digitized 22 AMNH specimens, including all those featured by Gregory in his seminal monograph on *Notharctus* and collections made by AMNH crews starting in the late 1980's; 16 NMNH specimens including those studied by Gazin in the mid-20<sup>th</sup> century; 6 previously undescribed specimens from the Burke Museum; and a Duke-catalogued skeleton discovered in 2015 and digitally prepared to preserve *in situ* bone positions.

Initial research using this sample has been able to better constrain intraspecific variance in various cranial and postcranial variables allowing more confident identification of features reflecting interspecific behavioral diversity and phylogenetic affinities. When complete, this collection will represent the richest source of anatomical data for any fossil primate yet developed.

This work is supported by NSF BCS-1440742 and NSF BCS-1558555 (to DMB and GFG) and BCS-1440588 (to JIB).

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### The Effects of Age and Sex on Long-term Spatial Memory

MARIA D. GONZALEZ<sup>1</sup>, MALVIN JANAL<sup>2</sup>, RACHELLE WOLK<sup>1</sup> and ELENA CUNNINGHAM<sup>1</sup>

<sup>1</sup>Basic Sciences, New York University College of Dentistry, <sup>2</sup>Epidemiology and Health Promotion, New York University College of Dentistry

We investigated the influence of age, sex and dominance on performance in a learning task in a strepsirrhine primate, *Eulemur mongoz*. *E. mongoz* live in small family groups and are characterized by female dominance. We collected data from five groups at the Lemur Conservation Foundation in Florida. Lemurs were tested in social groups of two or three individuals. Six or nine containers, one third of which were baited with cantaloupe were placed in consistent locations for five learning trials and six test trials in the lemurs' habitual enclosures. We collected data on agonistic interactions and the order in which the lemurs investigated the containers, opened the containers, and ate the cantaloupe. We analyzed the number of unique visits of each individual to baited and empty to containers until all the baited containers were visited. The expected ratio of visits to baited and empty containers is 0.5. During the test trials, the ratio for adult males was 0.96, for adult females it was 0.84, and for offspring it was 2.25. Adult females were dominant to all other members of the group. Although they initially visited fewer baited sites than adult males or offspring, they ate the most cantaloupe because they displaced other individuals. The study found that lemurs can remember the location of baited containers and there is a difference in learning across different ages, where younger lemurs are more capable of remembering baited locations. The results also suggest an interaction of social and cognitive factors in an experimental foraging task.

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### The Neolithic transition at the Western edge of Europe

GLORIA M. GONZALEZ FORTES<sup>1</sup>, TASSI FRANCESCA<sup>1</sup>, GHIROTTI SILVIA<sup>1</sup>, HENNEBERGER KIRSTIN<sup>2</sup>, HOFREITER MICHAEL<sup>2</sup> and BARBUJANI GUIDO<sup>1</sup>

<sup>1</sup>Dipartimento di Scienze della Vita e Biotechnologie, University of Ferrara, <sup>2</sup>Adaptive and Evolutionary Genomics Group, University of Potsdam

For a long time, the dynamics of the spread of farming into Europe has been the subject of an intense debate. The open question is to what extent the observed archaeological differences are due to either cultural or biological processes. Ancient DNA (aDNA) studies have strongly contributed to shedding light on this topic, through the recovery and analysis of an increasing number of mitochondrial and nuclear

genomes from prehistorical human samples. Far from closing the debate, these palaeogenomes are revealing a more complicated scenario, where the times, paths and genetic legacy of the Neolithic diffusion seem to have been different in different geographic areas. The Iberian Peninsula (IP), at the Western edge of Europe, is a particularly challenging scenario for understanding the relative role of migration and cultural changes, being the last European region reached by the Neolithic diffusion.

In the present study we generated novel genome data from ancient human remains from the Mediterranean and Atlantic watersheds of the IP. By combining state-of-the-art technologies for the recovery of aDNA from petrous bones and whole genome capture strategies we have been able to recover whole mitochondrial genomes and nuclear genome data. The new genetic data are revealing different genetic backgrounds for the northern and southern ancient populations and a higher genetic diversity than previously described in these areas. We are also presenting novel 14C dates, which together with the genetic data complete the picture to understand the different migrational influences and times of arrival of the Neolithic into the IP.

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### Why are Men's faces More Easily Recognized as Male? Evolutionary Conditioning of Perceptual Biases

TOMAS GONZALEZ-ZARZAR<sup>1</sup>, JOSE FERNANDEZ<sup>5</sup>, MARK BEASLEY<sup>6</sup>, ARSLAN ZAIDI<sup>3</sup>, PETER CLAES<sup>4</sup>, MARK D. SHRIVER<sup>1</sup> and JENNIFER K. WAGNER<sup>2</sup>

<sup>1</sup>Anthropology, The Pennsylvania State University, <sup>2</sup>Bioethics, Geisinger Health System, <sup>3</sup>Biology, The Pennsylvania State University, <sup>4</sup>ESAT/PSI - UZ Leuven, iMinds, Medical IT Department, KU Leuven, <sup>5</sup>Nutrition Sciences, The University of Alabama at Birmingham, <sup>6</sup>Biostatistics, The University of Alabama at Birmingham

Studies have found that men's faces are more accurately recognized as male than women's faces are recognized as female, evidence that has been explained by others as reflecting a greater level of danger posed by encounters with men. To better understand why this interesting difference occurs, we investigated facial perceptions of attractiveness, credibility, aggressiveness, and masculinity/femininity using two experiments through an online survey platform. In experiment 1, 599 observers viewed 96 faces, presented as a rotating 3D gif image with grey texture map, and rated traits on a Likert scale. In experiment 2, we conducted a replication and asked 1,694 people to judge the sex of 500 faces in the same conditions described above. In both experiments, we found support for the perceptual male bias hypothesis (male faces are more accurately perceived as such; both Exp1 and 2; p-value<0.001), and

some support for the hypothesis that females have greater ability in face recognition (Exp1: p-value=0.09; Exp2: p-value=0.003). We also found sex differences in the association between sex identification and perceived traits. Both perceived attractiveness (females: r=0.41, p-value=0.002, males: r=0.39, p-value=0.01) and masculinity (females: r=-0.96, p-value<0.001, males: r=0.72, p-value<0.001) were significantly correlated with accuracy in sex perception in the direction expected. However, perceived aggressiveness (r=-0.62, p-value<0.001) and credibility (r=0.56, p-value<0.001) were only significantly correlated in females. This evidence suggests that perceptions of aggressiveness are not necessarily mediating the accuracy of sex judgments in males but, rather, the perception of sex-typical traits as suggested by perceived masculinity. These results are discussed in terms of perceptual biases and human sexual selection.

### Skeletal Stress Markers in Undocumented Border Crossers: A Comparative Approach

ALEXIS GOOTS, LAUREN A. MECKEL, DEVORA S. GLEIBER and ALEJANDRA AYALA BAS

Anthropology, Texas State University

The purpose of this project is to employ several anthropological methods to examine skeletal stress markers in Undocumented Border Crossers (UBCs) found deceased on the Texas/Mexico border. The traits considered as indicators of high stress are low cranial base height, ectocranial porosity (EP), low cortical area (CA), prevalence of double zonal (DZ) and drifting osteons in the rib, and spina bifida. We predicted that the UBCs would show a higher frequency of stress markers across all methods used when compared to those observed in White individuals from the Texas State Donated Skeletal Collection (TSDSC).

Four of the six variables show significantly higher levels of stress in the UBC sample compared with the TSDSC. Cranial base height was significantly lower in the UBCs (n=36) as compared with the TSDSC (n=30) (p=0.0037). Additionally, UBCs have a significantly higher prevalence of EP than TSDSC with self-reported middle socioeconomic status (p<0.005). Finally, in the left 6th rib, UBCs displayed higher DZ (p<0.01) and drifting osteons (p<0.02) when compared with the TSDSC (n=10).

The stress markers that are present in the UBC sample are just as informative as those that are absent. For example, the low prevalence of spina bifida suggests that inadequate nutrition may not be the primary motivator for migration; instead, psychosocial factors, such as violence, may play a significant role in the decision to migrate. These results have broad implications for elucidating the physiological and psychosocial stressors that may provide impetus for migration into the United States.

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### Intraspecific Variation and Functional Morphology in the Humerus of Cercopithecoids

ASHLEY GOSSELIN-ILDARI

Evolutionary Anthropology, Duke University

Variation in morphological features of the humerus are well established as associated with substrate preference in extant primates and therefore frequently used in behavioral reconstructions of fossil taxa. However, these associations are typically based on species mean data, small samples per species, or qualitative criteria. Thus an understanding of how intraspecific variation affects the behavioral predictive value of the humeral traits in a quantitative framework is largely lacking. This study examines the degree to which morphological features of the humerus reflect behavioral preferences when intraspecific variation is considered. Several aspects of the humerus were measured using calipers and digital photographs from a sample including 40 cercopithecoid species. Preliminary observation of intraspecific variation in size standardized variables reveals substantial overlap between species with different behavioral categories even when species mean values differ in the expected direction. For example, the arboreal taxa *Cercopithecus ascanius* and *Macaca fascicularis* have mean values for greater tubercle projection (0.131 and 0.133, respectively), which are lower than the values for taxa that engage in more terrestrial behavior such as, *Chlorocebus pygerythrus* (0.148), *Cercocebus torquatus* (0.141), and *Mandrillus sphinx* (0.15). However, the ranges for these taxa demonstrate substantial overlap. This pattern is also observed to a lesser extent in the direction of the medial epicondyle, another morphological feature used commonly in fossil behavioral reconstruction. The potentially confounding effect of intraspecific variation will be further considered in the context of absolute body size, sexual size dimorphism, and evolutionary divergence dates.

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### A Survey of Crossing Structures among Captive Primates

LESLIE E. GOTUACO, INDIA J. BROCK, COLIN M. BRAND, ULRIKE S. STREICHER and LARRY R. ULIBARRI

Anthropology, University of Oregon

Habitat fragmentation is an increasing problem and we are just beginning to understand its effects on animal ecology. There have been efforts to connect forest patches for primates with bridge-like structures, but to date this is still a trial and error undertaking and there is not much literature on the subject. However, zoos are a valuable source of information about potentially successful bridge-like structures.

They include a multitude of such structures in primate enclosures, and have accumulated a wealth of experience and information. In order to compile and evaluate this information, we created a preliminary survey. We disseminated this survey to 524 zoos, research centers, and sanctuaries and defined a bridge-like structure as a suspended structure angled between 0 and 45 degrees that connects two elements of an enclosure without additional support. A bridge does not include transfer or connecting tunnels, which are enclosed on all sides or vertical climbing structures. We received responses from 51 institutions. 49 of these facilities maintained primates in enclosures with bridge-like structures consisting of 93 species. Bridges were reported to vary in length depending on species ranging from 1 to 180 meters and were composed of various materials including rubber, fire hose, and wood. Based on these results, institutions were contacted with a more indepth survey. These data contribute to the accumulation and evaluation of information to develop and trial suitable road crossing structures for primates in the wild, and enhance the use and utility of bridge-like structures for primates in captivity.

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### Seasonality and Neanderthal Hunting Strategies

LIONEL GOURICHON<sup>1</sup>, WILLIAM RENDU<sup>2</sup>, STEPHAN NAJI<sup>3</sup>, MORGAN HASSANI<sup>1</sup>, ERIC PUBERT<sup>2</sup> and CARLOS SANCHEZ-HERNANDEZ<sup>4</sup>

<sup>1</sup>Université Côte d'Azur (Nice), CNRS-CEPAM,

<sup>2</sup>Université de Bordeaux, CNRS-PACEA, <sup>3</sup>Department of Anthropology, New York University, <sup>4</sup>Universitat de Tarragona (Spain), IPHES

Neanderthal mobility patterns have become a major topic in recent research in Paleoanthropology. In particular, the spatial organization of activities in the Neanderthal's territory has been largely used to discuss their management of food resources and scheduling abilities and indirectly to approach their cognitive capacities. Given this background, the seasonality of hunting is obviously a key factor for identifying both the spatial and temporal organization of the subsistence economy.

Several scholars have assumed that Neanderthal subsistence economy integrated the use of communal hunting strategies and reliance on delayed consumption of food resource that was frequently exported to camp sites. However, since most of the studies focused on late Neanderthal populations, little information is available for earlier populations making difficult to discuss the development through time of such planning strategies.

Here, through the study of cementum seasonal increments of animal teeth from several sites in Southwestern France and Northern Spain attributed to the MIS4-5, we investigate the seasonal

organization of the Neanderthal populations during the MIS4-5 period. Although the samples are affected by a great variety of micro-taphonomic alterations (microbial attacks, chemical diagenesis), results of the cementochronological analyses provide reliable evidence of restricted times of large game predation for a number of archaeological contexts.

This study was notably funded by the CemeNTAA Project (ANR-14-CE31-0011).

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### Indentured: Bioarchaeological Evidence for Pauper Apprentices in Nineteenth Century Yorkshire, England

REBECCA L. GOWLAND<sup>1</sup>, ANWEN CAFFELL<sup>1</sup>, MICHELLE ALEXANDER<sup>2</sup>, LESLIE QUADE<sup>1,2</sup>, ANDREW MILLARD<sup>1</sup>, MALIN HOLST<sup>2</sup>, POPPY YAPP<sup>2</sup> and CHLOE BROWN<sup>2</sup>

<sup>1</sup>Archaeology, Durham University, <sup>2</sup>Archaeology, University of York

During the industrialisation of the 18<sup>th</sup> and 19<sup>th</sup> centuries children were believed to be healthier in a rural rather than an urban environment. A recent bioarchaeological study of urban and rural differences in the health of children from the North of England suggested that this pattern may not be quite so clear-cut. Equal prevalence rates of metabolic disease were noted at both, while the rural site showed greater evidence for growth disruption and respiratory disease. This poster will focus in more detail on the skeletal indicators of poor childhood health from the rural site of Fewston, North Yorkshire (n=154). Through the integration of historical evidence, including the skeletal remains of identified individuals, it highlights the heterogeneity of life experiences for children during this period. Results of osteological and isotopic analysis of the Fewston skeletons reveal a distinctive group of adolescent skeletons. When integrated with historical data, the evidence suggests that these are the remains of pauper children forced to work in the local textile mill. For the first time, this study presents bioarchaeological insights into the lives of pauper apprentices. These young individuals were removed from workhouses in London and indentured to a life of toil in the mills of the North of England. Our view of rural/urban health during this period must take into account the dire consequences of social inequities.

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### A chimpanzee-sized ancestor of the earliest hominins and unusual patterns of body size evolution in the hominid clade

MARK GRABOWSKI<sup>1,2,3</sup> and WILLIAM L. JUNGERS<sup>4,5</sup>

<sup>1</sup>Department of Anthropology, American Museum of Natural History, <sup>2</sup>Centre for Ecological and Evolutionary Synthesis, University of Oslo, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, George Washington University, <sup>4</sup>Association Vahatra,

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<sup>5</sup>Department of Anatomical Sciences, Stony Brook University

Body size directly affects how an animal relates to its environment, and no trait has a wider range of biological implications. However, little is known about the size of the last common ancestor (LCA) of humans and chimpanzees, hominids (great apes and humans), or hominoids (all apes and humans). This void impacts numerous paleobiological hypotheses at and prior to the root of our lineage. Here we use phylogenetic comparative methods and body mass data from fossil hominins, Miocene fossil apes from Africa and Europe, and extant primates including humans to test alternative hypotheses of body size evolution, modeled in R via SURFACE according to an Ornstein-Uhlenbeck process. Our results show that, contrary to previous suggestions, the LCA of all hominoids likely lived in an environment that favored a gibbon-like size, but a series of selective regime shifts, possibly due to resource availability, led to a decrease and then increase in body size in early hominins from a chimpanzee-sized LCA. In addition, whereas most of primate evolution is characterized by shifts towards only two optimal body sizes, hominids are unique among primates in having a significantly greater number of adaptive optima due to poorly understood but distinct selective regimes across evolutionary time. These results imply that: 1) a chimpanzee-sized LCA preceded a decrease prior to later increases in early hominin body mass; 2) gibbons are not a dwarfed lineage, supporting recent fossil findings; and 3) a complex and changing adaptive landscape characterized body size evolution in the hominid clade.

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## Postcranial Sectioning Points Derived from the Terry Collection for Utility in Sex Estimation in Historical Contexts

DEBORAH D. GRAHAM<sup>1,2</sup>, AMANDA K. COSTELLO<sup>3</sup> and KAREN E. BRUN<sup>4</sup>

<sup>1</sup>Department of Heritage and Arts, Utah Division of State History, <sup>2</sup>Department of Anthropology, Salt Lake Community College, <sup>3</sup>Department of Anatomy and Neurobiology, Boston University School of Medicine, <sup>4</sup>School of Physician Assistant Studies, University of Florida College of Medicine

Given the overall utility and practicality of postcranial univariate sectioning points for sex estimation (Spradley and Jantz, 2011; Albanese et al. 2005) it is surprising that little reference material exists for application in historical contexts for North American populations. Sectioning points derived by Spradley and Jantz (2011) using the Forensic Anthropology Data Bank apply only to modern North American Black and White populations and thus have no utility in historical contexts due to secular change (Trotter and Gleser, 1951; Meadows and Jantz, 1995; Jantz

and Meadows Jantz, 1999; Shirley and Jantz, 2010). Sectioning points with utility in historical contexts provided by Albanese et al. (2005) are limited to data obtained from only humeri and femora of a Canadian cemetery population. In the present study, metrics from the Terry Collection Postcranial Osteometric Database are used to calculate univariate sectioning points for multiple standard measurements of eight skeletal elements, including the clavicle, scapula, humerus, radius, ulna, femur, tibia, and fibula, following Albanese et al. (2005). These newly derived sectioning points provide users with preliminary reference material and improve the applicability of sectioning points in rapidly estimating sex in North American Black and White historical skeletal populations. Additionally, results from the present study are compared with those from Spradley and Jantz (2011) in order to address variation in sectioning points, accuracy rates, and to explore secular trends.

## Intraspecific Variation during Quadrupedal Locomotion in Mammals

MICHAEL C. GRANATOSKY<sup>1</sup>, PIERRE LEMELIN<sup>2</sup>, CALLUM F. ROSS<sup>1</sup>, ERIC MCELROY<sup>3</sup> and DANIEL SCHMITT<sup>4</sup>

<sup>1</sup>Organismal Biology and Anatomy, University of Chicago, <sup>2</sup>Division of Anatomy, Department of Surgery, Faculty of Medicine and Dentistry, University of Alberta, <sup>3</sup>Biology, College of Charleston, <sup>4</sup>Evolutionary Anthropology, Duke University

The wide diversity of locomotor behaviors observed in primates is often attributed to their higher level of intrinsic locomotor flexibility compared to other mammals. No study has evaluated whether primates actually are unusual in this regard. To fill this gap, we explored intraspecific variation during quadrupedal walking in primate and non-primate mammals. Kinetic, kinematic, and spatiotemporal gait variables (41 variables analyzed) collected from ten species of primate and six species of non-primate mammals (N = 870 strides) were evaluated using principal component analysis. From the resulting three-dimensional point clusters, dimensionless hull volumes for each species were compared statistically as a measure of variability. We observed statistical differences in the position of primates and non-primate mammals in multivariate locomotor space, differences largely driven by variation in duty factor, diagonality, and vertical force impulse. However, no significant differences between primate and non-primate mammals were detected for our measure of intraspecific variation during quadrupedal walking. The importance of this study is two-fold: (1) this represents one of the few studies that considers mammalian locomotor behavior in multivariate space and demonstrates its effectiveness as an analytical tool, and (2) it provides statistical evidence that primates are not unusual compared to

non-primate mammals in levels of variability observed during quadrupedal locomotion. These similar levels of variation in the quadrupedal gaits of mammals may represent basal neuromuscular adaptations that coordinate oscillations of multiple components of the locomotor system, and increase predictive motor control to minimize effects of external perturbations.

*This research was funded in part by the Leakey Foundation, Force and Motion Foundation, National Science Foundation's Graduate Research Fellowship Program, Molly Glander award, and Duke University Internal Funding.*

## Structural Racism, Genetic Variation, and Hypertension among African Americans: Evidence from HEAT Heart Health

CLARENCE C. GRAVLEE<sup>1</sup>, JACKLYN QUINLAN<sup>1</sup>, RAFFAELE VACCA<sup>1</sup>, CHRISTOPHER MCCARTY<sup>1</sup>, P. QASIMAH BOSTON<sup>2</sup>, M. MIAISHA MITCHELL<sup>2</sup> and CONNIE J. MULLIGAN<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>Steering Committee, Health Equity Alliance of Tallahassee

Excess hypertension in the African Diaspora has puzzled researchers for generations. Many researchers and clinicians assume that people of African ancestry are genetically predisposed to develop high blood pressure. Others propose that social stressors linked to systemic racism likely contribute to racial inequalities in hypertension. Few studies, however, have seriously examined both genetic and sociocultural influences on high blood pressure in people of African descent. Here we use a collaborative, biocultural approach to examine the interplay of novel sociocultural and genetic contributors to blood pressure among African American adults (N=157) in Tallahassee, FL. Data come from the HEAT Heart Health Study, which integrates ethnography, social network analysis, cardiovascular epidemiology, and genetics in a community-based participatory (CBPR) framework. Drawing on ethnographic and network data, we first demonstrate the cultural salience of vicarious racism, or exposure to race-based discrimination through the experience of others. We then test for associations between blood pressure, discrimination to self, vicarious racism, and more than 30,000 single nucleotide polymorphisms (SNPs) in a joint admixture and genetic association analysis. We identify significant interaction effects between vicarious racism and five SNPs in four genes associated with multiple psychological phenotypes, including mood disorders and psychosocial stress, but only one interaction between a SNP and discrimination to self. Our findings expand our understanding of structural racism and demonstrate the value added by a collaborative, biocultural approach that examines sociocultural and genetic influences on health with equal rigor.

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## Signaling human fathering potential

PETER B. GRAY  
Anthropology, UNLV

How does a man signal his fathering potential? I draw upon evolutionary theory, cross-cultural research, social psychology experiments and U.S. survey findings to address this question. Much evidence suggests that males seek to advertise their social status to enhance mating and reproductive opportunities, as mates are often sensitive to the resources and other benefits attached to a potential father's status. Fathers can provide a socioecologically variable array of valuable services such as resources, protection and direct childcare. In some cases, potential fathers may display cues of formidability, in other contexts cues of kindness. Multiple lines of evidence implicate male cues of long-term partnership compatibility such as religious beliefs and personality, with cues of compatibility helping sustain a long-term reproductive relationship and a father's continued investment. In some contemporary U.S. social contexts, data suggest how a man treats his own and a potential partner's pets may even offer insight into his potential as a father. The evaluation of potential stepfathers also offers distinct life history challenges, as men may feel differentially invested in children fathered by other men and parents face potential tradeoffs between mating and parenting effort. Data suggest careful evaluation of a potential stepfather's involvement with one's own children. Theoretically, signals of fathering potential are vulnerable to sexual conflicts. Evidence suggests some male traits such as voice pitch and upper body musculature have been shaped more by male-male competition than female choice. Costly signaling models, including a man's reputation, constraint dishonest signals of a man's fathering potential.

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## Phosphate-water $\delta^{18}\text{O}$ offset revision improves paleoclimatic reconstructions

DANIEL R. GREEN<sup>1</sup> and ALBERT S. COLMAN<sup>2</sup>  
<sup>1</sup>Human Evolutionary Biology, Harvard University,  
<sup>2</sup>Geophysical Sciences, University of Chicago

Hydrological and climatic characteristics of hominin and other paleontological environments are reconstructed with the aid of oxygen stable isotope values ( $\delta^{18}\text{O}$ ) from vertebrate fossil remains. These reconstructions rely upon models linking environmental oxygen sources to blood  $\delta^{18}\text{O}$ , and a phosphate-water  $\delta^{18}\text{O}$  offset that remains unresolved. Here, we raise a flock of sheep (n=6) under controlled conditions to improve physiological water models and solve the problem of the phosphate-water offset. We find

that under experimental conditions, the scale of body water  $\delta^{18}\text{O}$  variation and overall  $\delta^{18}\text{O}$  enrichment are determined by two seasonally-sensitive ratios: that of drinking to metabolically derived oxygen, and that of fractionated to unfractionated water loss. We employ high-resolution sampling of enamel phosphate  $\delta^{18}\text{O}$  in the second molar of each sheep. Using this method, we determine a phosphate-water offset that minimizes model-measurement mismatch. We find that the control animal supports an offset of +19.1‰, and results from experimental animals converge on this value as the duration of water switch treatment is reduced. One important result of this observation is to provide support for the phosphate water calibration determined by Puceat *et al.* (2010) in actinopterygian fish, suggesting an offset consistent among osteichthyans or vertebrates generally. More broadly, this finding eliminates a longstanding phosphate-water offset uncertainty of almost 3‰ (16.8-19.7‰), one third of the variation observed in fossil  $\delta^{18}\text{O}$  measurements taken from herbivores in northern Kenya, a critical site of hominin fossil remains.

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## The Evolutionary and Ontogenetic Context of Fossil Hominin Scapulae

DAVID J. GREEN<sup>1,2,3</sup>, TED A. SPIEWAK<sup>2</sup>, JOSEPH P. KELLY<sup>2</sup>, BRIELLE C. SEITELMAN<sup>1</sup>, JOSEPH R. KRECIOCH<sup>1</sup>, PHILIPP GUNZ<sup>4</sup> and ZERESEY ALEMSEGED<sup>5</sup>

<sup>1</sup>Department of Anatomy, Northwestern University, <sup>2</sup>Chicago College of Osteopathic Medicine, Northwestern University, <sup>3</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand, <sup>4</sup>Department of Human Evolution, Max Planck Institute, <sup>5</sup>Department of Organismal Biology and Anatomy, University of Chicago

Recent geometric morphometric (GM) analyses of three-dimensional, semilandmark scapular data highlighted similarities among modern human and African ape scapulae that support the parsimonious notion that their last common ancestor (LCA) possessed an African apelike scapula. This runs counter to previous work utilizing static landmark data demonstrating phenetic links between human and orangutan scapulae. Including fossil hominin data is essential to critically evaluate these conflicting results, but considering the DIK-1-1 and KNM-WT 15000 juvenile scapulae alongside those of MH2 and extant hominoids requires developmental context. Here we present an ontogenetic GM analysis of 98 semilandmarks placed along the boundary of the subscapularis fossa as a general outline of scapular blade shape.

Modern *Homo* and *Gorilla* individuals overlapped considerably with superoinferiorly broad

scapulae, as opposed to those of *Hylobates* that display markedly elongated lateral borders. *Pan* has mediolaterally compressed scapulae relative to *Pongo*, but both groups display intermediate superoinferior breadths. The KNM-WT 15000 scapula is superoinferiorly broad like *Homo*, and both it and MH2 have mediolaterally compressed blades, but MH2 is superoinferiorly narrower and fell at the *Homo/Pan* juncture. DIK-1-1 is moderately broad superoinferiorly and mediolaterally, and fell among *Gorilla* individuals adjacent to the *Pongo* data. Age was not a significant factor, as shape did not demonstrably change among the extant taxa from DIK-1-1's developmental stage through adulthood. Moreover, growth simulations largely resulted in "adult" versions of DIK-1-1 that were more *Gorilla*-like than the fossil itself. Put together, these results support the hypothesis that the LCA had an African apelike scapular shape.

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## Variation in the Interface of Brain and Skull

SEAN Y. GREER<sup>1</sup>, IAN D. GEORGE<sup>2</sup> and KRISTINA ALDRIDGE<sup>1</sup>

<sup>1</sup>Pathology & Anatomical Sciences, University of Missouri School of Medicine, <sup>2</sup>Anatomical Sciences, Stony Brook University

Endocasts have long been used to infer brain surface morphology due to the close approximation of brain and skull and their coordinated development. Previous research has focused on the two tissues themselves, while the space between them remains underexplored. Given the importance of this space in the interpretation of endocast and skull morphology, we examine the pattern of variation in subarachnoid space (SAS) within and among individuals.

Our study sample included magnetic resonance images (MRIs) of demographically-matched young adult human males (N=15). We used Avizo 7© to reconstruct 3D surfaces of the brain and the endocranium using dura mater as a proxy for bone. We collected 3D landmark coordinate data on both surfaces and calculated interlandmark distances spanning the SAS between analogous landmarks. We calculated descriptive statistics using R.

Our results indicate that SAS is highly variable across the cranium. While the SAS is greatest on average in the basicranium (> 1 cm), the SAS of the superior vault is the most variable (standard deviations between 5 and 6 mm). The smallest and the least variable of the areas examined here is the SAS of the lateral cranium (consistently < 1.0 mm).

The overall size of the subarachnoid space is an important consideration in studying the

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relationship of brain and skull. However, the pattern of variation in this space across different intracranial regions may have significant implications for studies of pathology and reconstructing brain evolution.

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### Lineage and Lifestyle in Early Bronze Age Jordan: A Biogeochemical Investigation of Charnel House Human Remains

LESLEY A. GREGORICKA<sup>1</sup> and SUSAN G. SHERIDAN<sup>2</sup>

<sup>1</sup>Department of Sociology, Anthropology, & Social Work, University of South Alabama, <sup>2</sup>Department of Anthropology, University of Notre Dame

The EBII-III (2900-2500 BCE) at Early Bronze Age Bab adh-Dhra', Jordan was characterized by a major shift in social organization, evidenced by the construction of a walled settlement, agricultural intensification, and the appearance of charnel houses. These mortuary structures are important for understanding social changes that took place during this time because they represent the only cemetery in use during the EBII-III on the Dead Sea Plain for which we have skeletal evidence today. However, the relationship between these charnel houses and the hundreds of commingled individuals interred therein remains poorly understood. One interpretation contends that they acted as symbols of ancestral authority and were each controlled by different kin groups whose social status and/or activity patterns may have differed from one another. Subsequently, it was hypothesized that distinct patterns of mobility and dietary intake may be evident between kin groups at the site. This hypothesis was tested by analyzing strontium and carbon isotopes from human dental enamel recovered from two contemporary EB II-III charnel houses at Bab adh-Dhra' – designated as A22 (n=14) and A55 (n=7). Strontium isotope ratios between A22 (0.70826 ± 0.00013) and A55 (0.70834 ± 0.00002) were significantly different from one another, as were carbon isotope values (A22 = -13.5 ± 0.3‰; A55 = -13.1 ± 0.3‰). Members of charnel house A22 consumed a more varied diet and were more mobile than those interred in A55, suggesting that these structures may have been managed and utilized by separate kin groups.

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### Measuring digit ratios from 2D hand scans versus negative handprints: Implications for archeology

ALLISON P. GREMBA<sup>1</sup>, CHRISTOPHER TORGALSKI<sup>2</sup> and SETH WEINBERG<sup>1,3</sup>

<sup>1</sup>Department of Anthropology, University of Pittsburgh, <sup>2</sup>Swanson School of Engineering,

University of Pittsburgh, <sup>3</sup>Center for Craniofacial and Dental Genetics, University of Pittsburgh

The second to fourth digit ratio (2D:4D) is a sexually dimorphic trait. Digit ratios obtained from 2D hand scans of modern populations have been used to create discriminate functions to classify the sex of Paleolithic negative handprints found in caves. It is unclear, however, if 2D hand scans are a reliable proxy for negative handprints, potentially calling into question their usefulness in archeological applications. In this study, we tested the correspondence between digit measurements obtained from 2D hand scans and simulated negative handprints.

2D hand scans (via flatbed scanner) and negative handprints (via sprayed body paint on a white background) were collected on 30 participants (21 females and 9 males). Digit lengths were collected and used to calculate 2D:4D for each method. For 2D hand scans, measurements were collected in tpsDig2. For negative handprints, measurements were collected with digital calipers. Paired t-tests were used to compare mean 2D:4D between the two methods.

Mean 2D:4D from the 2D scans was 0.97 (range: 0.91-1.09), while mean 2D:4D from the negative handprints was 0.99 (range: 0.90-1.20). This difference was significant (p<0.001). Sex differences in 2D:4D tended to be greater with the negative handprints (F=1.00, M=0.97) than in 2D hand scans (F=0.97, M=0.97).

In conclusion, the negative handprints produced higher digit ratios with greater variability compared to 2D hand scans. Negative handprints may exaggerate sex differences in 2D:4D. These factors should be taken into account when attempting to interpret Paleolithic handprints.

### Locomotor mode and kinematics of the head, neck, and trunk in *Varecia variegata*

NEYSA GRIDER-POTTER<sup>1</sup> and ANGEL ZEININGER<sup>2</sup>

<sup>1</sup>School of Human Evolution and Social Change, Institute of Human Origins, Arizona State University, <sup>2</sup>Department of Evolutionary Anthropology, Duke University

During locomotion, the primate axial skeleton plays a vital role in both stability and mobility. Despite its functional significance, few experimental studies have explored kinematics of the head and neck. Lemurs are the ideal model to experimentally examine axial function as they use a wide range of locomotor modes. This study investigates kinematics of the head, neck, and trunk during the most common modes of locomotion in *Varecia variegata*, arboreal and terrestrial quadrupedalism. We hypothesize that locomotor mode affects axial movement and predict that arboreal quadrupedalism necessitates a greater amount of transverse plane movement than terrestrial quadrupedalism, as side-to-side trunk

movements may improve balance when walking on narrow a substrate.

Palpable axial landmarks of two *V. variegata* housed at the Duke Lemur Center were marked with non-toxic paint. Locomotor bouts were filmed with five synchronized Sony Handycams. Three-dimensional landmarks were digitized in DLTdataviewer. Transverse, coronal, and sagittal plane angles were calculated in R. Results show no significant difference in transverse or coronal plane movement of the axial skeleton across locomotor modes. However, there were significant differences in sagittal plane movement. In comparison to terrestrial locomotion, the head is more anterior-inferiorly inclined while the trunk is more anterior-superiorly inclined during arboreal locomotion. During terrestrial walking, the head and neck exhibit a greater range of sagittal plane movement (flexion/extension). This study demonstrates the variability in axial movement and posture during locomotion within one species of primate. This variability is important to consider when inferring functional morphology in fossil primates.

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### Breast milk macronutrient content in rural West African mothers is impacted by season of infant birth and maternal energy balance

MARGARET A. GRUCA<sup>1</sup>, SOPHIE E. MOORE<sup>2</sup>, MOMODOU K. DARBOE<sup>3</sup>, ANDREW M. PRENTICE<sup>3</sup> and ROBIN M. BERNSTEIN<sup>1,4</sup>

<sup>1</sup>Department of Anthropology, University of Colorado Boulder, <sup>2</sup>Division of Women's Health, King's College London, <sup>3</sup>MRC Unit, The Gambia, <sup>4</sup>Health and Society Program, Institute of Behavioral Science, University of Colorado Boulder

Rural Gambian infants often experience intense growth faltering early in life, influenced by season of birth and multiple related effects, including those mediated through maternal health and activity associated with increased maternal agricultural workload. Here, we test the influence of birth season and maternal factors on breast milk macronutrient content (fat (FAT), total protein (TOP), true protein (TRP), and lactose (LAC)), measured by mid-infrared spectroscopy (Lactoscope FTIR Advanced, Delta Instruments), in milk collected monthly across the first year of lactation from 217 mothers living in rural Gambia. We also assessed the effect of variation in milk macronutrients on infant growth. Controlling for infant sex and repeated measures, linear mixed models results indicate that maternal factors with significant positive influence on variation in milk macronutrients include: weight (LAC and TRP, p<0.05), triceps skinfold (FAT, p<0.01), weight gain in pregnancy (FAT and TRP, p<0.01),

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and weight change in the first 12 weeks of lactation (TRP,  $p < 0.05$ ). Infants born in the dry season received milk with lower levels of FAT and LAC ( $p < 0.01$ ). After adjusting for maternal factors, infants who received milk with higher TRP had higher weight-for-height (WHZ) and weight-for-age (WAZ) z-scores ( $p < 0.05$ ), and those that received milk with less FAT and LAC had lower height-for-age (HAZ) scores ( $p < 0.05$ ). Our results suggest that in this study cohort, infant birth season and markers of maternal energetic status influence variation in milk macronutrient content, which impacts infant growth.

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### **Preliminary findings on relationships among neural canal dimensions, terminal adult stature, and risk of death in a medieval Polish sample at Bezlawki**

ARIEL GRUENTHAL-RANKIN<sup>1,2</sup>, MARISSA RAMSIER<sup>2</sup>, ARKADIUSZ KOPERKIEWICZ<sup>3</sup> and MAREK POLCYN<sup>4</sup>

<sup>1</sup>Department of Anthropology, Binghamton University, <sup>2</sup>Department of Anthropology, Humboldt State University, <sup>3</sup>Department of Archaeology, University of Gdansk, <sup>4</sup>Department of Anthropology, Lakehead University

The use of non-specific stress indicators, such as vertebral neural canal (VNC) dimensions and terminal adult height, in the analysis of early-life stress has gained popularity in bioarchaeology in recent years. Previous research has demonstrated a correlation between reduced transverse diameter of lower thoracic and lumbar vertebrae and risk of early mortality. The present study analyzed antero-posterior (AP) and transverse (TV) neural canal dimensions from the second cervical vertebrae (C2) through the first sacral vertebrae (S1) for association with risk of death, by age class, in 27 individuals from the medieval (mid-14<sup>th</sup>-early 15<sup>th</sup> century) Polish site of Bezlawki. The results of this analysis demonstrated that individuals within the 16-25 year-old age class had significantly reduced transverse diameters in several thoracic vertebrae (T4-6 and T12) and in the first lumbar and first sacral vertebrae. These findings support previous studies which suggest that the transverse dimension of the VNC is more prone to growth disruption due to its extended growth period. Terminal adult stature for this age group was not significantly different from survivors. Results of the analysis of the youngest age class (ages 10-15) demonstrate stenosis of the VNC in lumbar vertebrae 1-3. These findings may suggest inhibition of typical developmental remodeling of the VNC, or premature fusion of the VNC in non-survivors of this age class. More robust sample sizes are necessary to determine if the pattern of reduced

transverse thoracic dimensions, seen in the 16-25 age class, is reflected in the youngest age group.

### **Infant handling in mountain gorillas: establishing its frequency, function and (ir)relevance for life history evolution**

CYRIL C. GRUETER<sup>1</sup>, JENNIFER HALE<sup>1</sup>, RUIBING JIN<sup>1</sup>, DEBRA S. JUDGE<sup>1</sup> and TARA S. STOINSKI<sup>2</sup>

<sup>1</sup>School of Anatomy, Physiology and Human Biology, The University of Western Australia, <sup>2</sup>Karisoke Research Center, The Dian Fossey Gorilla Fund International

Infant handling describes cases in which youngsters are temporarily removed from the care of their mothers and 'taken care of' (held, carried etc) by other conspecific contemporaries. Handlers may gain indirect fitness benefits from these actions and can practise mothering skills, thereby improving the odds of survival of their own infants. Great apes are notable for displaying little infant handling. Apart from anecdotal observations, no published data exist on infant handling in wild mountain gorillas. We tested two of the most pertinent explanations ('kin selection' and 'learning to mother') in a wild population of mountain gorillas in Rwanda. We predicted that (a) nulliparous females would exhibit infant handling (i.e. carrying) more than parous females and (b) maternal kin would exhibit more infant handling than non-kin. Collation of 8 years of data on carrying behavior collected in 13 groups monitored by the Dian Fossey Gorilla Fund's Karisoke Research Center revealed that infant handling is an infrequent behaviour (1783 instances over 25,600 observation hours). When modelling infant handling using a Quasi-Poisson GLM, a strong positive effect of relatedness (but not parity) on the frequency of infant handling emerged. Moreover, male infants were handled more than female infants. While the nature of handler-infant interactions (affiliative, abusive etc) remain unstudied, they could constitute alloparental care and could therefore attenuate maternal energetic burden and ultimately allow increased birth rates. However, the rarity of this behavior makes it an unlikely contributor to the gorillas' relatively short inter-birth intervals.

### **Signals of Ecogeography and Phylogeny in the Macaque Dentition (Cercopithecidae: *Macaca*)**

NICOLE D.S. GRUNSTRA<sup>1,2</sup>, ROBERT A. FOLEY<sup>1</sup> and PHILIPP MITTEROECKER<sup>2</sup>

<sup>1</sup>Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Theoretical Biology, University of Vienna

We studied variation in the craniodental phenotype of macaques to investigate the evolutionary impact of climate, ecology, and spatial geography. We analysed both between- and within-species patterns, to compare microevolutionary and macroevolutionary patterns. We

hypothesized an environmental association with allometry in association with temperature, known as Bergmann's rule. Although the macaque dentition is generalized, we also explored the presence and nature of dietary signals.

Linear measurements of tooth and craniofacial size were taken on 735 specimens, pertaining to 12 species. We used two-block partial least squares to investigate the covariance between morphology, climate, and ecology, as well as reduced rank regression to identify spatial gradients in craniodental variation. To assess the effect of phylogeny, we carried out our analyses with and without phylogenetic correction (based on a molecular phylogeny).

Our results indicate a dominant effect of allometry on between-species variation, in response to colder environments and latitude. A dental size contrast was associated with rainfall and resource ecology. Tropical species that feed primarily on fruits exhibit enlarged anterior teeth. By contrast, non-tropical macaques that have a more varied diet exhibit a larger postcanine dentition. While these two patterns did not change with phylogenetic correction, the dietary pattern was diminished in magnitude following phylogenetic adjustment. Within species, we found no evidence of environmental plasticity, nor of drift, demonstrated by the lack of isolation by distance. Thus, on a low taxonomic level, phylogenetic constraints may have a strong impact, in addition to adaptation, which is relevant for the study of fossil hominins.

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### **Sex Differences in Walking Kinematics among Modern Humans**

LAURA T. GRUSS<sup>1</sup> and CARA WALL-SCHEFFLER<sup>2</sup>

<sup>1</sup>Biology, Radford University, <sup>2</sup>Biology, Seattle Pacific University

Inferences about extinct hominin locomotion are often made by interpreting fossil morphology in light of biomechanical patterns observed in modern human walking. Occasionally sexual dimorphism in early hominin locomotion has been suggested based on fossil anatomy, but insufficient attention has been paid to sex-specific variation in locomotor patterns among modern humans, and particularly how those patterns might relate back to sex differences in morphology. This study compared the kinematics of walking in 12 male and 14 female subjects walking at multiple speeds, including preferred and maximum speeds.

Men were absolutely larger in basic anthropometrics; women had relatively broader pelvises. There were no differences in the range of speeds at which subjects chose to walk. Men took

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absolutely longer strides ( $p=0.015$ ), and relied on increasing stride length as speed increased. Women used greater stride frequencies (SF) at all speeds ( $p=0.002$ ), and increased SF more than men with increases in speed. Women also trended towards increased pelvic rotation as speed and SF increased. Patterns of vertical oscillation of the center of mass (COM), a variable that has been implicated in locomotor efficiency, differed between the sexes ( $p=0.008$ ). In men, COM movement increased linearly with speed, but in women it remained low across speeds. Thus, by employing increased pelvic rotation, women limit COM oscillations, and are able to achieve high walking speeds in an economical manner. These results may allow more specific hypotheses about locomotor mechanics, a better tie with morphology, and clearer interpretation of sexual dimorphism in the fossil record.

### The Hormonal and Elemental Composition of Dehydrated Human Placenta Capsules

LAURA K. GRYDER<sup>1,2</sup>, SHARON M. YOUNG<sup>2</sup>, WINNIE B. DAVID<sup>3</sup>, YUANXIN TENG<sup>3</sup>, DAVID ZAVA<sup>4</sup>, DAVID W. KIMBALL<sup>4</sup>, SHAWN GERSTENBERGER<sup>1</sup> and DANIEL C. BENYSHEK<sup>2</sup>

<sup>1</sup>School of Community Health Sciences, University of Nevada Las Vegas, <sup>2</sup>Department of Anthropology, University of Nevada Las Vegas, <sup>3</sup>Department of Geoscience, University of Nevada Las Vegas, <sup>4</sup>ZRT Laboratory, Beaverton, Oregon

Human maternal placentophagy, the postpartum ingestion of the placenta by the mother, is a rare but growing practice among postpartum mothers in industrialized countries. Women engage in this behavior in order to reap the purported health benefits associated with the practice. Often, the placenta is steamed, dehydrated, pulverized, and encapsulated prior to ingestion, and is taken as a postpartum supplement in the weeks following childbirth. Placentophagy advocates claim that placenta capsules contain hormones and nutrients that are beneficial for new mothers, and that ingestion of these capsules can aid in postpartum recovery. Critics of the practice, however, have suggested that the cooking and dehydration process likely destroys any beneficial hormones or micronutrients present in the placenta at parturition. Despite the growing popularity of the practice, the hormonal and nutritional content of dehydrated placenta capsules has not been evaluated. In order to address the nutritional and hormonal content of placental tissue that has been processed for encapsulation, 28 dehydrated placenta samples were analyzed to evaluate the concentration of 17 hormones using liquid chromatography tandem-mass spectrometry (LC-MS/MS), and 14 trace minerals/elements using inductively coupled plasma mass spectrometry (ICP-MS). The results revealed detectable concentrations of 16 hormones, including estrogens and progestogens, and all 14 elements, including modest concentrations

of iron, selenium, zinc, and copper. These results suggest that dehydrated placenta capsules may contain hormones in concentrations that could potentially elicit physiological effects, and may also provide a modest source of some trace micronutrients.

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### "It Sucks To Be A Boy On His Period": Language Ideologies, "Women's" Health, & Trans\* Communities

AMANDA E. GUITAR and SABINA M. PERRINO  
Anthropology, Binghamton University, SUNY

A biocultural medical perspective should consider the impact of reproductive systems as well as cultural factors related to gender that can affect health within society. However, many health researchers fail to differentiate between the biological category of sex and the sociocultural construct of gender. The conflation of these two terms reinforces ideologies of these constructs as strict dualisms and neglects the health concerns of many patients, including trans\* individuals. In this presentation, we argue that this oversight extends to the very labels that some health researchers identify under. Through analyzing field data, including oral narratives, digital material, and other linguistic materials collected from researchers as well as trans\* individuals, this presentation explores the implications of identifying as a "women's" health researcher, due to an interest in female reproductive physiology. How do these dichotomous word choices limit inquiries into the health of those who may have female reproductive systems, but do not identify their gender as a woman? Who is addressing the health concerns of those who identify as a woman, but do not have female reproductive physiology? Finally, how does this language choice contribute to a scientific definition of what a "woman" is? Through a linguistic anthropological lens, biocultural health researchers can better understand how language ideologies influence their own research and the societal implications of the terms they utilize. By engaging in an interdisciplinary analysis, this presentation makes an important contribution to current anthropological debates about disciplinary boundaries and how to overcome them.

### Early anthropoid dental eruption and development

GREGG F. GUNNELL<sup>1</sup>, ELLEN R. MILLER<sup>2</sup>, ERIK R. SEIFFERT<sup>3</sup>, HESHAM M. SALLAM<sup>4</sup> and GARY T. SCHWARTZ<sup>5</sup>

<sup>1</sup>Division of Fossil Primates, Duke Lemur Center,

<sup>2</sup>Department of Anthropology, Wake Forest

University, <sup>3</sup>Department of Cell and Neurobiology,

University of Southern California, <sup>4</sup>Department of Geology, Monsoura University, <sup>5</sup>Institute of Human Origins, Arizona State University

Schultz's rule states that species with 'slow' life histories will exhibit late eruption of molars relative to premolars, while species with 'fast' life histories will show relatively early eruption of molars versus premolars. Although there are exceptions, primates generally follow Schultz's Rule, with most anthropoids having a 'slower' pattern and most strepsirrhines a 'faster' one. Some studies have suggested that this delayed maturation was also present among primitive basal anthropoids. If true, this would potentially mean that adoption of a slower life history trajectory was integral to what it means to be an anthropoid. If not, then perhaps a slower life history is more closely tied to the generally larger body/brain sizes of crown anthropoids. To investigate this, tooth emergence sequences were documented using  $\mu$ CT scans for four species of early Fayum (Egypt) anthropoids representing different families; the enigmatic stem family Proteopithecidae (*Proteopithecus sylviae*), the stem family Parapithecidae (*Parapithecus grangeri*), and the crown families Oligopithecidae (*Catopithecus browni*) and Propiopithecidae (*Aegyptopithecus zeuxis*). Results show that *A. zeuxis* exhibited the 'slow' maturation pattern characteristic of extant catarrhines but patterns in the other species were less uniform. Instead, emergence sequences in these species predominantly document a pattern of having all molars in place before permanent premolars. However, observed emergence patterns appear to differ somewhat and to be unique to individual species. These results indicate that the delayed maturation characteristic of extant anthropoids was not present among all basal anthropoids, but that the pattern had been established by the time of appearance of Propiopithecidae

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### Correlates of energetic status among female chimpanzees at Ngogo, Kibale National Park using urinary C-peptide

SHOLLY GUNTER<sup>1,2</sup>, KEVIN B. POTTS<sup>3</sup> and JANINE L. BROWN<sup>4</sup>

<sup>1</sup>Biology, McLennan Community College,

<sup>2</sup>Anthropology, Yale University, <sup>3</sup>Biology, Saint Olaf

College, <sup>4</sup>Center for Species Survival, Smithsonian Conservation Biology Institute

Urinary C-peptide (UCP) is a byproduct of insulin production that has been used to track proxy measures of energetic status in wild primates. Studies have found that UCP levels reflect energy intake, as measured by food availability, feeding rates, and diet quality. Research also suggests that UCP levels demonstrate the negative energy balance expected in lactating females. We investigated the impact of demographic and

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environmental variables on UCP levels in female chimpanzees at Ngogo. We used generalized linear models to examine the effects of reproductive status, age class, food availability (FAI), feeding time, travel time, and percent of total feeding time eating ripe fruit (RF). Based on our best fit model ( $\chi^2 = 86.77$ ,  $df = 4$ ,  $p < 0.001$ ), only FAI (high:  $B = 0.361$ ,  $p < 0.001$  low:  $B = -0.306$ ,  $p < 0.001$ ), RF ( $B = -0.064$ ,  $p < 0.01$ ), and interaction of feeding and travel ( $B = 0.127$ ,  $p < 0.01$ ) had a significant effect on UCP levels. Contrary to some studies, we did not find an effect of reproductive status on UCP levels, possibly due to increased energy intake in lactating females. The negative relationship between RF and UCP is unexpected. The high fructose content of the preferred fruit at Ngogo may offer some explanation, as fructose consumption does not stimulate the production of C-peptide. Further research examining the relationship between UCP and caloric/nutrient consumption could help clarify some of the inconsistencies between reports of UCP in wild primates.

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### Khoe-San and the origins of modern human cranial diversity

PHILIPP GUNZ, SARAH E. FREIDLINE and JEAN-JACQUES HUBLIN

Human Evolution, Max Planck Institute for Evolutionary Anthropology Leipzig

A number of fossils from North, South, and East Africa document the early stages of our species, and fossils from the Levant document the presumed first wave of migration out of Africa. However, large gaps in the fossil record make it difficult interpreting the evolutionary processes and population dynamics shaping the cranial diversity of modern humans.

Here we use 3D geometric morphometrics based on landmarks and semilandmarks to compare cranial shape in a worldwide sample of recent and fossil humans from Africa, Europe, and Asia ( $N=256$ ). Given that many *Homo sapiens* fossils are larger than recent *Homo sapiens*, we use multivariate regressions of cranial shape on cranial size to quantify static allometry and visualize how evolutionary changes of cranial size within the modern human lineage affect cranial shape.

We show that in a principal component analysis of shape Upper Paleolithic *Homo sapiens* fossils fall close to the center of all recent modern humans. Notably, Khoe-San also cluster near the center of recent *Homo sapiens* and are close in shape to Upper Paleolithic fossils and Qafzeh 9. The present-day Khoe-San therefore retain many aspects of the ancestral *Homo sapiens* cranial morphology, however much less pronounced owing to a gracilization of cranial features that

occurred before the Holocene. Our results reconcile cranial morphology with recent genetic studies, which have identified deep genetic roots of the Khoe-San.

### Cultural Attitudes Toward Primate Conservation

SHARON GURSKY

Anthropology, Texas A&M University

While extensive non-human primate conservation research has been conducted in Indonesia, there have only been a handful of projects that address how local Indonesians perceive wildlife and conservation efforts. From June-August 2015 I conducted 75 interviews in the village Batuputih Sulawesi Indonesia. This village abuts Tangkoko Nature Reserve. Demographic information including age, sex, occupation, education and religion were collected. In addition, information pertaining to personal feelings and beliefs about tarsiers, macaques and nature were also obtained. All interviews were conducted in Indonesian, recorded on a digital recorder for later translation. The results of this preliminary study demonstrate that there is no difference between males and females, or between Muslims and Christians, in terms of their attitude toward nature or conservation. However, as level of education increased, so did positive attitudes toward nature and conservation. Individuals with a high school education regularly believed conservation was important while those with only an elementary level education rarely reported that conservation or nature is important. Over 85% of the people interviewed had difficulties with monkeys raiding their gardens. More than 60% of the people interviewed had a monkey or a tarsier as a pet in their home. The preliminary results of this study suggest that despite more than 30 years of conservation efforts in Tangkoko Nature Reserve by WWF, WCS, as well as many local NGOs, the local villagers still do not believe conservation is important. More effort toward educating the local populace should be a priority for conservation agencies.

### Atherosclerosis in contemporary preindustrial populations: does it exist and is it clinically relevant?

MICHAEL D. GURVEN<sup>1</sup>, BENJAMIN C. TRUMBLE<sup>2</sup>, JONATHAN STIEGLITZ<sup>3</sup>, BRET BEHEIM<sup>4</sup>, AARON D. BLACKWELL<sup>1</sup>, DAVID MICHALIK<sup>5</sup>, ADEL H. ALLAM<sup>6</sup>, CHRISTOPHER ROWAN<sup>7</sup>, BRUNO FROHLICH<sup>8</sup>, LINDA SUTHERLAND<sup>9</sup>, JAMES D. SUTHERLAND<sup>10</sup>, JAMES K. MIN<sup>11</sup>, CALEB E. FINCH<sup>12</sup>, SAMUEL WANN<sup>13</sup>, RANDALL C. THOMPSON<sup>14</sup>, GREGORY S. THOMAS<sup>15</sup> and HILLARD S. KAPLAN<sup>16</sup>

<sup>1</sup>Department of Anthropology, University of California, Santa Barbara, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Institute for Advanced Study in Toulouse, <sup>4</sup>Human Behavior, Ecology and Culture, Max Planck Society for

Evolutionary Anthropology, <sup>5</sup>Pediatrics and Infectious Diseases, University of California, Irvine School of Medicine, <sup>6</sup>Al Azhar Medical School, <sup>7</sup>Renown Institute for Heart and Vascular Health, <sup>8</sup>National Museum of Natural History, Smithsonian Institution, <sup>9</sup>Newport Diagnostic Center, <sup>10</sup>South Coast Radiologic Medical Group, <sup>11</sup>Weill Cornell Medical College, <sup>12</sup>Davis School of Gerontology, University of Southern California, <sup>13</sup>Columbia St Mary's Healthcare, <sup>14</sup>University of Missouri-Kansas City School of Medicine, <sup>15</sup>Long Beach Memorial Medical Center, <sup>16</sup>Department of Anthropology, University of New Mexico

Atherosclerosis is often believed to have been rare among ancestral humans, with its high global prevalence today attributed to rapid changes in modern lifestyles, especially diet, physical activity, smoking and infection. Yet recent computerized tomographic (CT) scans of mummified remains spanning 4,000 years shows evidence of atherosclerosis globally (Peru, Aleutian Islands, Egypt, American Southwest). The HORUS team thus concluded in their 2013 *Lancet* paper that atherosclerosis is "an inherent component of human ageing and not characteristic of any specific diet or lifestyle". One important lens for viewing health and disease in evolutionary context is the biomedical study of subsistence-level societies living under relatively traditional conditions without modern amenities. We employ advanced, non-invasive methods to assess heart disease in a large sample of Tsimane forager-farmer adults over age 40 ( $n=731$ , age 40-93 years). Chest CT is employed to diagnose atherosclerosis, while electrocardiograms, echocardiograms and Doppler ultrasound are used to assess any clinical manifestations of coronary heart disease. We find evidence of low-level arterial calcification among Tsimane, at lower prevalence and magnitude than U.S. controls from the Multiethnic Study of Atherosclerosis (MESA). Despite evidence of atherosclerosis among Tsimane, we find minimal evidence that such atherosclerosis has clinically relevant manifestations. Utilizing verbal autopsies, we discount mortality selection as a possible explanation for the lack of clinical relevance. We conclude that while atherosclerosis has likely been "stalking mankind for thousands of years", it was likely not an important source of morbidity or mortality for much of human history.

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### A Lack of Cathemeral Activity in *Varecia variegata* in Kianjavato, Madagascar

NICOLA K. GUTHRIE<sup>1</sup>, SHEILA M. HOLMES<sup>1</sup>, ADAM D. GORDON<sup>2</sup>, EDWARD E. LOUIS JR.<sup>3</sup> and STEIG E. JOHNSON<sup>1</sup>

<sup>1</sup>Anthropology and Archaeology, University of Calgary, <sup>2</sup>Anthropology, University of Albany, <sup>3</sup>Conservation Genetics, Omaha's Henry Doorly Zoo and Aquarium

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Cathemeral activity (active in both day and night) has been identified in few primate species so far, with the majority of cathemeral species being lemurs in four of the five Lemuridae genera. Anecdotal accounts of cathemeral activities in the fifth genus, *Varecia*, have not been studied systematically. Data were collected on *Varecia variegata* from June to August 2016 at Kianjavato Ahmanson Field Station, Madagascar. Instantaneous focal sampling at 5-minute intervals was conducted during the night, with all night (4pm – 6am, n = 4), partial night (4pm – 12am, n = 11) and twilight follows (4pm – 8pm and 4am to 8am the following morning, n = 2) on 15 individuals. During the night, *V. variegata* were active 1.1% of the time. In comparison, the same individuals were active 24.0% of the time during the day. The ratios of diurnal to nocturnal activity for cathemeral and diurnal species are typically 3.4:1 and 8.2:1. In this study the ratio was 21.9:1, strongly suggesting that during the austral winter at KAFS, *V. variegata* are not cathemeral ( $\hat{I}S^2(1) = 61.329, p < 0.0001$ ). These results are also congruent with previous data obtained at the same field site using accelerometer collars which recorded activity across seasons. These findings suggest that the ancestral condition for the family Lemuridae may not be cathemeral as previously suggested.

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### Two Potential Cases of Eunuchism from a Ptolemaic-Roman Cemetery in the Western Delta of Egypt: Differential Diagnosis and Social Implications

SCOTT D. HADDOW<sup>1</sup>, SONIA ZAKRZEWSKI<sup>2</sup> and JOANNE ROWLAND<sup>3</sup>

<sup>1</sup>PACEA, University of Bordeaux, <sup>2</sup>Department of Archaeology, University of Southampton, <sup>3</sup>School of History, Classics and Archaeology, University of Edinburgh

Excavations conducted between 2007 and 2013 at the Ptolemaic-Roman cemetery site at Quesna, located in the western Delta of Egypt, have revealed the skeletal remains of 151 individuals. During these excavations, two individuals buried with above average stature and completely unfused epiphyses were discovered in separate burials. One individual was interred in a mudbrick tomb containing additional, non-affected decedents. The other was interred discretely in an unusual position in relation to other burials in the cemetery, and with a large number of funerary amulets. In this presentation we propose and evaluate two potential etiologies for the observed osteological conditions: one genetic, involving disruption of normal endocrinal functions, and the other cultural, involving the excision of the testes (i.e. castration) at an early age. An exploration of the skeletal and historical evidence for the presence of eunuchs in Ancient Egypt is also presented. Regardless of the etiology, however,

these individuals would likely have appeared sexually ambiguous in life, and this presumably had far-reaching social implications involving gender roles, identity and mortuary treatment.

### The vertebral column of La Chapelle-aux-Saints: the evidence of spinal osteoarthritis for Neanderthal spinal curvature

MARTIN HAEUSLER<sup>1</sup>, CINZIA FORNALI<sup>1,2</sup>, NAKITA FRATER<sup>1</sup> and NOÉMIE BONNEAU<sup>1</sup>

<sup>1</sup>Institute of Evolutionary Medicine, University of Zürich, Switzerland, <sup>2</sup>Department of Anthropology, University of Vienna, Austria

Boule's reconstruction of the La Chapelle-aux-Saints Neanderthal skeleton as lacking a lumbar lordosis, but instead displaying a thoracic hyper-kyphosis and a straight neck with a primitive, forward inclined head position shaped the popular notion of Neanderthals as brutish creatures. Later, La Chapelle-aux-Saints' posture and distinct spinal curvature was attributed to pathology or to Boule's misinterpretation of the morphology, implying that the actual vertebral curvature of La Chapelle-aux-Saints did not differ from modern humans. Recent studies of the orientation of the inferior articular processes, however, again suggested a hypolordotic, flat lower back and spinal dysbalance in this individual as well as in Neanderthals in general.

Here, we use the distribution and the degree of the osteoarthritic changes as an alternative means to deduce spinal curvature in La Chapelle-aux-Saints. We observed extensive degenerative changes including Bastrup's disease and nearthroses in the lower lumbar spine due to disc space loss, and severe facet joint osteoarthritis with vertical subluxations in the lower thoracic and cervical spine. They suggest an increased lumbar lordosis extending into the lower thoracic region and a clear cervical lordosis in this old individual. On the other hand, a reconstruction of the pelvis indicates a human-like pelvic incidence of 56°, implying a lumbar lordosis close to the mean of modern humans in the undiseased condition as a young adult.

Our findings suggest that the analysis of degenerative changes is a valuable tool to reconstruct posture and spinal motion in Neanderthals that supplements other methods including inferences of articular process angles.

We thank the *Muséum Nationale d'Histoire Naturelle de Paris* for access to *La Chapelle-aux-Saints*. Financial support was provided by the *Swiss National Science Foundation (31003A-156299/1)* and the *Mäxi Foundation, Switzerland*.

### Comparison of Five Different DNA Extraction Methods for Reconstructing Ancient Gut Microbiomes from Coprolites

RICHARD W. HAGAN<sup>1</sup>, COURTNEY HOFMAN<sup>1</sup>, KARL REINHARD<sup>3</sup>, KRITHIVASAN

SANKARANARAYANANN<sup>2</sup> and CHRISTINA WARINNER<sup>1</sup>

<sup>1</sup>Anthropology, University of Oklahoma, <sup>2</sup>Microbiology and Plant Biology, University of Oklahoma, <sup>3</sup>School of Natural Resources, University of Nebraska Lincoln

The study of biological anthropology is currently expanding to include studies of the variation of the human microbiome. This important feature of human biology is emerging as a critical factor for understanding health and disease. Existing studies have compared the microbiomes of traditional societies with those of Western, industrialized ones, and there is growing interest in including the microbiomes of past peoples in these analyses. Coprolites, or palaeofaeces, provide a unique opportunity to reconstruct the gut microbiomes of past peoples through metagenomic analysis of ancient DNA. While this approach has already been used with varying degrees of success, little is known about how extraction methods impact ancient DNA recovery from coprolites. In this study we compared 5 different extraction methods for recovering ancient DNA from coprolites, including the protocol from the Human Microbiome Project and silica column extractions designed specifically for the recovery of ancient DNA. Our results show that commercial extraction kits used in the Human Microbiome Project are less efficient at ancient DNA recovery, but do not impact the overall microbial community structure as determined by downstream metagenomic analyses. Our findings highlight the importance of extraction strategy when working with coprolites, particularly when considering the preservation of the sample. Metagenomics via ancient DNA offers an exciting opportunity to understand the evolution of the human microbiome, and studies such as this one are vital for ensuring accurate analyses.

### Innate Food Aversions and Culturally Transmitted Food Avoidances in Pregnancy: Separate Systems to Protect the Fetus?

EDWARD H. HAGEN and CAITLYN D. PLACEK  
Department of Anthropology, Washington State University

Two evolutionary theories have been proposed to explain culturally transmitted pregnancy food proscriptions. The first posits that individual disgust responses are transformed into institutionalized food taboos. The second posits that individual and social learning results in the cultural evolution of proscriptions of foods that are dangerous in pregnancy, independent of disgust reactions. Here we investigate the relationship between psychophysiological food aversions and culturally transmitted food avoidances among two populations of pregnant women in Mysore, India: a mixed caste rural farming population (N=72), and the Jenu Kuruba,

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a resettled population of former hunter-gatherers (N=30). Women completed structured interviews that assessed aversions and socially learned avoidances of foods, pathogen exposure, food insecurity, sources of dietary advice, aversions to food photos, and sociodemographic information. There was little overlap between psychophysiological aversions and culturally transmitted food avoidances. Culturally proscribed foods were believed to be abortifacients or otherwise harmful to the fetus. Ranking logistic regression models of aversions and avoidances by AIC and assessing performance by Tjur's D found that the cultural transmission model was the highest ranked and best performing model of food avoidances, but did not predict food aversions, which were best predicted by trimester. Proscriptions were primarily transmitted vertically from the mother and grandmother, and obliquely from the mother-in-law. These results indicate that food proscriptions culturally evolved to protect the fetus, independent of individual food disgust responses, supporting the second theory. Pregnancy-related food aversions and culturally transmitted food avoidances appear to be two distinct strategies to protect fetuses from pathogens and teratogens.

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### Comparing the habitats of 3.5–3.2-million-year-old hominins at Woranso-Mille and Hadar, Ethiopia

YOHANNES HAILE-SELASSIE

Physical Anthropology, Cleveland Museum of Natural History

Woranso-Mille, located in the central Afar region of Ethiopia, plays a pivotal role in addressing middle Pliocene hominin diversity. It not only samples an important, but under-represented, time period in human evolution (3.3-3.8 Ma), it is also the only site that has thus far yielded evidence for the existence of at least two hominin taxa in close temporal and spatial proximity during the middle Pliocene - *Australopithecus afarensis* and *Australopithecus deyiremeda*. A major question is how they can live in close proximity at Woranso-Mille given that they likely utilized similar resources. Using multiple proxies, this study reconstructs the habitats of *Australopithecus afarensis* and *Australopithecus deyiremeda* at Woranso-Mille where they co-existed. It also compares their faunal assemblages with contemporaneous assemblages from four sub-members within the Sidiha Koma Member at Hadar, where *Australopithecus afarensis* is best known. Results of the comparison show that there are more similarities than differences in mammalian species representation and inferred habitats at Hadar and Woranso-Mille. However, stable isotope data from fossil teeth and pedogenic carbonates indicate that Woranso-Mille at

3.5–3.3 Ma had more C<sub>3</sub>-dominated landscapes than the Sidiha Koma Member, which is inferred to have been the most closed habitat within the Hadar Formation. Absence of some of the more closed habitat taxa at Hadar and their presence at Woranso-Mille, along with the "Burtele foot", a hominin whose taxonomic affinity is not yet determined, lend support to this inference. However, these preliminary results need further testing with better temporal and spatial resolution at Woranso-Mille.

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### What is a genus? Understanding craniodental diversity in *Callicebus*

LAUREN B. HALENAR<sup>1,2</sup> and SIOBHÁN B. COOKE<sup>2,3</sup>

<sup>1</sup>Department of Biology, Farmingdale State College, SUNY; <sup>2</sup>NYCEP Morphometrics Group, CUNY; <sup>3</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

Recently, the number of named taxa across Primates has increased dramatically. *Callicebus* has been particularly affected as there are now as many as thirty-four recognized species compared to the two recognized by Hershkovitz in 1963. This increase is based on a high degree of variation in karyotype number and pelage coloration, but little work has been done on skeletal morphology. The most recent molecular phylogenetic study suggests that the commonly recognized species groups should be sorted into three genera: *Cheracebus* for the *torquatus* group from the Orinoco and upper Amazon basins, *Plecturocebus* for the *cupreus/moloch* and *donacophilus* groups of the central Amazon, and *Callicebus* for the *personatus* group of the Atlantic Coastal Forest.

We address this issue through the quantification of craniodental diversity within *Callicebus sensu lato* using a 3DGM approach. Landmarks were collected on ~100 individuals from thirteen species. There is extensive overlap in shape-space between species of the *cupreus* and *moloch* groups, supporting molecular work suggesting they be collapsed. This single *moloch* group is distinct from the *donacophilus* group due to its larger orbits, wider cranium, and shorter face. The *personatus* and *torquatus* groups are distinct from one another as well, with the *personatus* group possessing a longer neurocranium, more klinorynch maxilla, and orbits oriented frontally as opposed to superiorly. Dentally, there is substantial overlap amongst all species groups, with the *torquatus* group showing slightly more dental relief. The magnitude of craniodental variation within *Callicebus* described here is not great enough to justify separation into three genera.

### Osteomas on the cranial vault: Survey of presence and frequency Erin N. Hall<sup>1</sup> and David R. Hunt<sup>2</sup>. <sup>1</sup>Department of Anthropology, Catholic University, <sup>2</sup>Department of Anthropology, Smithsonian Institution

ERIN HALL

Anthropology, The Catholic University of America

There have been few reports in the anthropological literature on the distribution and frequency of osteomas on the human cranium. Usual published reports are individualistic observation of extreme growths or in cemetery population analyses. This investigation surveys the presence of osteomas on the cranial vault for the entire Robert J. Terry Anatomical Collection (n=1728), and for comparative purposes, cranial materials from 12<sup>th</sup> Dynasty Egypt (n=63), 15<sup>th</sup> century Peru (n=542), and 20<sup>th</sup> century Chinese & Mongolians (n=63). Visual assessment was made of the entire cranial vault, from the superior orbital rim to the nuchal line and between the auditory meatus. Presence was recorded by location on each element and size variants were observed. Terry Collection individuals were divided into sex and ancestry to evaluate any differences in these groups. Terry Blacks had a slightly higher frequency (9.8%) to Whites (8.6%) and Terry Males had a slightly higher frequency (White males – 9.3%; Black males – 10.6%; White females – 7.5%; Black females – 8.7%). Osteomas in the other world populations was surprisingly lower with the Egyptians at 1.9%, Peruvians at 1.5% and Chinese/Mongolians at 4.8%. From the Terry Collection it was found that most osteomas were located on the parietal (n=107), with no significant lateral preference; secondly on the occipital (n=53), with no lateral preference; and thirdly on the frontal (n=49), with an observable lateral preference to the right side. Multiple osteomas in individuals were rare and there is an age component to the presence of osteomas.

### Healed Rib Fractures: A Micro-anatomical Assessment

KATE MW. HALL and R R. PAINE

Sociology, Anthropology, and Social Work, Texas Tech University

This study presents an assessment of micro-anatomical features specific to healed rib fractures. Twenty-nine fractured and healed ribs from 17 individuals with known demographics and medical histories are examined. Rib fractures are placed into three categories based on the size of the callus relative to normal rib circumference. Recently healed fractures are defined by a ratio of 1.47-1.24, moderately healed fractures by 1.22-1.16, and well-healed by 1.15-1.02. Three thin sections are prepared for each rib according to standard histological procedures.

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These sections are obtained from the unfractured bone 5cm from the callus, the edge of the callus, and the midpoint of the callus. Histological variables include: cortical area, cortical thickness, woven area, primary area, and secondary area. A standard light microscope and Pax-it! image analysis software are employed to assess the variables. Ratios of primary to secondary bone are created to assess the degree of remodeling in each thin sections. Data are compared across thin sections in the same rib and across the three categories of fractures. Results indicate that fractures have a greater ratio of newly formed woven bone to secondary bone. However, fractures do not necessarily have greater cortical thickness than normal bone. Importantly, there is no consistent pattern of micro-anatomical features across the three fracture groups. This suggests that an assessment of healed fractures requires an understanding of the time between the injury and the death of the individuals. Gross morphology alone is not an adequate means for classifying post-traumatic interval.

### Rethinking Neonatal Brain Size: Birth Timing Relative to Brain Growth and Neurodevelopmental Schedules in Primates and other Mammals

ANDREW C. HALLEY<sup>1,2</sup> and TERRENCE W. DEACON<sup>2</sup>

<sup>1</sup>Center for Neuroscience, University of California, Davis, <sup>2</sup>Anthropology, University of California, Berkeley

How large are mammalian brains at birth, and why? Because brain tissue is metabolically expensive to grow and maintain, neonatal brain size is a commonly used proxy for preceding fetal growth patterns in studies of primate life history, brain/body allometry, paleoanthropology, and the energetics of prenatal development. Previous studies have linked various measures of neonatal brain size to a range of metabolic, life history, and neuroanatomical variables; these include relative basal metabolic rate, developmental state at birth (i.e. relative altriciality), placental morphology, and gyrencephaly, among others. However, these studies employ diverse analytic methods, and no systematic effort has yet been made to compare these measures with one other, or to describe their variation across species. Here we reexamine variation in primate and mammalian neonatal brain size by characterizing the timing of birth along ontogenetic plots of three central measures of growth: (1) ontogenetic brain/body allometry, (2) direct measures of fetal and perinatal brain growth, and (3) models of neurodevelopmental event timing. This analysis reveals several important relationships. First, altricial species from large litters are born earlier along brain growth and ontogenetic allometric trajectories. Second, body growth rates are primarily responsible for variation in brain/body allometric growth, with primates exhibiting exceptionally slow fetal somatic growth rates. Finally, peak brain growth

velocity in grams per day is an excellent predictor ( $r^2 = 0.99$ ) of adult brain size. We discuss several important consequences of these trends for the interpretation of neonatal brain size, both in extant mammals and fossil hominins.

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### The Shallow Biohistory of Recently-acquired Skeletal Material by the Louisiana Department of Justice

CHRISTINE L. HALLING and RYAN M. SEIDEMANN

Lands and Natural Resources, Louisiana Department of Justice

There is a general fascination among the public with the mortal remains of dead human beings. Modern fascinations with human remains, either as relics or curiosities, have been extensively considered in recent literature. This fascination with the dead occasionally leads to human remains coming into the possession of private individuals. Most of these remains are not of medico-legal significance (i.e. they are not evidence of a homicide). However, the circumstances of how particular human remains came to be in someone's possession—via the illicit artifact trade, pothunting, grave robbing, or other illegal exhumation—add to or create postmortem narratives for the remains. Determining the identity and ultimate disposition of such wayward remains influences biohistorical research and creates further postmortem narratives. Here we review the legal and biohistorical context of several recent acquisitions of human skeletal remains by the Louisiana Department of Justice that include materials used in alleged voodoo rituals and those sold by vampire shops in New Orleans and place these acquisitions within the broader context of the recent biohistory dialogues.

### Unique Habitat Sharing between Humans and Wild Chimpanzees in Sierra Leone: Ecological Implications for the Human-Primate Interface

ANDREW R. HALLORAN<sup>1</sup> and CATHERINE E. BOLTEN<sup>1,2</sup>

<sup>1</sup>Department of Chimpanzee Care, Save the Chimps, <sup>2</sup>Anthropology, University of Notre Dame

The Tonkolili Chimpanzee site is located along the Pampana River in Sierra Leone. It consists of a riparian forest and two forest fragments interspersed with a mosaic of farms, forest patches, villages, and savanna. Two chimpanzee communities, Mabureh and Komrabai, occupy separate core range forest fragments and utilize the mosaic as an overlapping home range. In 2014 we discovered a chimpanzee nesting site deep within the Komrabai core range. The site consisted of three

large mango trees (*M. indica*) interspersed with kola trees (*Cola nitida*), guava (*Psidium guajava*), yamani trees (*Thaumatococcus daniellii*), and oil palms (*Elaeis guineensis*) – all of which are cultivated by local human populations. The mango trees all stood >40m tall, forming the upper canopy of the forest. Within this canopy, there were >60 nests of varying ages. Most fresh nests had been constructed on top of older decaying nests. Camera trap data, the presence of fresh feces, and fresh chimpanzee tracks reveal that chimpanzees utilized the area on a regular basis. In 2016 we discovered that the area was once a village called Matambo, abandoned seventy years before. This unique landscape, which became a preferred nesting site once the trees matured, was the result of years of human intervention. This, along with the presence of high quality resources from previous cultivation, has made Matambo a primary territory for the Komrabai chimpanzees. These findings present new implications on the variables of human impacts on chimpanzee ecology, and how chimpanzees can adapt, even thrive, in anthropogenic habitats.

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### Social Status, Skeletal Biology, and the Lords of Sipán: Bioarchaeological Perspectives on the Moche Elite, North Coast Peru

ALLISON C. HAM<sup>1</sup>, HAAGEN KLAUS<sup>1,2</sup>, JACLYN THOMAS<sup>1</sup>, STEVEN BALL<sup>1</sup>, HILARIE HULEY<sup>1</sup>, GABRIEL BROWN<sup>1</sup>, JOHANNA YOUNG<sup>1</sup>, EDGAR BRACAMONTE LEVANO<sup>3</sup> and WALTER ALVA ALVA<sup>3</sup>

<sup>1</sup>Anthropology, George Mason University, <sup>2</sup>Museo Nacional Sicán, Peru, <sup>3</sup>Museo Tumbas Reales de Sipán, Peru

Clinical, theoretical, and bioarchaeological evidence identifies complex and sometimes unexpected links between social status and biological stress. On the north coast of Peru, previous analyses of skeletal remains from the hierarchical Middle Sicán state in the Lambayeque Valley (A.D. 900-1100) demonstrate strikingly different experiences of biological stress between elites and non-elites – with non-elites enduring greater degrees of morbidity. It is unknown if earlier, less hierarchical societies in this region also featured such relationships.

This study tests the hypothesis that the elites of the antecedent Moche culture (people who apparently wielded absolute sociopolitical and religious authority) were similarly buffered against biological stress. We conducted visual examination of 27 individuals from the high status Tombs 4 thru 16 at the renowned Moche site of Sipán (A.D. 300-400/450). Though extensively fragmented, the skeletal remains were relatively complete allowing for observation of enamel hypoplasias, anemia, scurvy, infectious diseases, degenerative

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joint disease, dental caries, antemortem tooth loss, periodontal disease, and abscesses. The results demonstrate a near total absence of skeletal pathological conditions, and we cannot reject the hypothesis. These Moche lords appear thoroughly buffered against biological stress and habitually strenuous physical activity while oral health data point to a high-quality diet. This work advances understandings of how social organization was biologically embodied and phenotypically expressed on the north coast of Peru and provides a key baseline for future comparative bioarchaeological studies, especially as lower status Moche skeletal samples are generated contributing to a more complete reconstruction of human biocultural variation in ancient Peru.

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### Strontium Isotope Ratios Indicate Mobility, Behavior Patterns in Modern Fauna from Kibale National Park, Uganda

MARIAN I. HAMILTON

Anthropology, University of New Mexico

Hominid behavioral evolution is difficult to study empirically because so few behaviors leave concrete traces in the fossil record. Mobility patterns, such as philopatric dispersal, home range size, and microhabitat preferences, have direct consequences on primate social behavior; strontium isotope ratios can potentially record these patterns of movement, providing an avenue for empirical behavioral reconstruction. However, correlations between environmental/faunal strontium isotope ratios and mobility patterns have never been tested in a living primate community, so their application to the fossil record remains theoretical. This study uses 172 water and plants samples from Kibale National Park, a rainforest in southwestern Uganda, to create a strontium isotopic map. Then, I used bone and tooth enamel isotope ratios from 97 individuals from 25 species, including chimpanzees, to address the following questions: 1) Can comparing an individual's tooth enamel (juvenile signature) and bone (adult signature) establish philopatry patterns, and can the local environmental ratio be used instead of bone? 2) Does intra-individual variability correlate with relative home range size? 3) Do particular microhabitats have unique strontium isotope signatures? Intra-individual tissue comparisons successfully identified the philopatric sex for all primates. Intra-individual variation accurately placed species in relative home range groups when differences exceeded tens of kilometers. Under certain environmental conditions, gallery forest micro-habitats were isotopically distinguishable from the surrounding woodland/savannah. This study confirms that strontium isotope ratios can be used to reconstruct mobility patterns provided

that there is an isotopically robust ecological baseline and provides a model for similar studies in fossil communities.

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### A Test of the Mastication Hypothesis on Mandibular Morphology using Medieval and Modern Non-adult Individuals

EMILY E. HAMMERL<sup>1</sup>, MEGAN K. MOORE<sup>2</sup>, ELIZABETH A. DIGANGI<sup>3</sup> and HEDY M. JUSTUS<sup>4</sup>

<sup>1</sup>Anthropology, University of Nebraska - Lincoln,

<sup>2</sup>Sociology, Anthropology, and Criminology, Eastern Michigan University,

<sup>3</sup>Anthropology, Binghamton University,

<sup>4</sup>Anthropology, Ohio State University

This research investigates the biomechanical role of mastication compared to genetic factors in the growth of the mandible in non-adults. Mandibular morphology, including corpus length and gonial angle, affects both dental alignment and crowding, often requiring orthodontic surgical intervention in modern populations to address pathology. Here we compare modern and early medieval samples. The early medieval sample is from Saleux, France and dates to the 7th-11th centuries (N=101). The combined modern sample includes individuals of European ancestry from the Case Western Bolton Brush Growth Study (42 females, 54 males). The majority of individuals in the modern sample have birth years after 1940. We demonstrate a significant difference in the growth and morphology of the mandible in these two samples by comparing gonial angle change. Additionally, the consequences of this secular change in the resulting bite force is calculated via numerical modeling. Results indicate individuals from the Saleux sample have significantly more robust mandibular morphology than the modern sample as measured by a less obtuse gonial angle ( $p < 0.05$ ). As a result, the modern sample has a decreased calculated bite force. We discuss these results in the context of both cultural behavior in the twentieth century compared to that of the early middle ages to test the mastication hypothesis and discuss possible outcomes for mandibular morphology in terms of both oral health and tooth alignment.

### Omo-Kibish pelvic morphology and implications for body form in the earliest modern humans

ASHLEY S. HAMMOND<sup>1</sup>, DANIELLE F. ROYER<sup>2</sup> and JOHN G. FLEAGLE<sup>3</sup>

<sup>1</sup>Center for Advanced Study of Human Paleobiology, Department of Anthropology, George Washington University,

<sup>2</sup>Department of Cell and Developmental Biology, University of Colorado-Denver,

<sup>3</sup>Department of Anatomical Sciences, Stony Brook University

The Omo-Kibish skeleton (Omo I) is the earliest known anatomically modern human (~195ka). Much of what we thought we knew about Omo I stems from the cranium, which was assumed to be a male primarily because of its large size, but a more recently-recovered os coxa from the same site has been preliminarily described as displaying female-like morphologies. If early modern human females were as large as Omo I, this could have important implications for the paleobiology of early modern humans.

Here we re-evaluate the sex of the Omo I hipbone based on indicators such as sciatic notch shape, preauricular sulcus form, and piriform tubercle morphology. We assess pelvic breadth by digitally re-aligning the ilium along the edge of a well-preserved step fracture. Finally, we predict stature from hip joint dimensions using published regression formulae.

The pelvic morphology of Omo I is consistent with a female sex attribution. The acetabulum size is large, even exceeding the size of many Neanderthals, resulting in stature estimates that are relatively tall for a female (172-184 cm). When the ilium is repositioned into a normal contour, pelvic breadth is consistent with that of lower latitude modern human populations. Our findings suggest that earliest modern humans were tall, and retained fairly robust postcrania like earlier Pleistocene hominins. Since breadth and size of the pelvis are associated with thermoregulatory adaptations, Omo I is key for understanding the pelvic morphology of the earliest modern humans prior to human global expansion, regional adaptation, and admixture.

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### Understanding human brain evolution through neuropathology: the case for Williams syndrome

KARI L. HANSON<sup>1,2,3</sup>, CAROLINE F. HORTON LEW<sup>1,2</sup>, URSULA BELLUGI<sup>2,3,4,5</sup> and KATERINA SEMENDEFERI<sup>1,2,3,4</sup>

<sup>1</sup>Anthropology, University of California San Diego,

<sup>2</sup>Center for Academic Research and Training in Anthropogeny (CARTA), University of California San Diego,

<sup>3</sup>Institute for Neural Computation, University of California San Diego,

<sup>4</sup>Neurosciences Graduate Program, University of California San Diego,

<sup>5</sup>Laboratory for Cognitive Neuroscience, Salk Institute for Biological Research

Comparative neuroanatomy is essential for characterizing unique elements of the human phenotype that underlie behavioral adaptations across hominoid taxa. Differences in development of brain areas observed in human and non-human primate brains likely underlie enhanced capacities for cultural acquisition

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and social organization derived in primate lineages, contributing to the emergence of more complex cultural behavior and cognition in humans. Alongside these studies, an understanding of the functional implications of derived neuroanatomical traits can be gained through analyses of human pathological development. In disorders affecting social cognition, typical cortical organization may be altered in critical ways, with implications for subcortical systems. Substantial variation in neuroanatomical phenotypes may result from vulnerabilities associated with recent adaptive genomic changes underlying human cognition. Williams syndrome (WS) is a rare neurodevelopmental disorder caused by a hemideletion of 1.6 Mb (25-28 genes) on chromosome 7, a highly dynamic region associated with recent adaptive selection in hominoid lineages. Here, we provide new evidence for variation in WS neuroanatomy underlying the unusual social and cognitive phenotype of the disorder. Specifically, we have found increases in neuron and glia density in the striatum, as well as variation in neuronal density of cortical layers in functionally distinct areas. These differences likely reflect alterations in typical neurodevelopmental events, including apoptosis and neuronal migration, guided by variation in gene expression and function. We suggest that the gene deletion involved in WS provides an ideal model for the study of human-specific genetic variation affecting the development of brain areas involved in social cognition.

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### Sex differences in dimorphic dental trait heritability in *Saguinus fuscicollis*

ANNA M. HARDIN

Anthropology, University of Minnesota

Sexual dimorphism in anthropoid primates is generally associated with sexual selection, particularly with male-male mate competition. Hypotheses regarding the evolution of canine size dimorphism often attribute sex differences in canine size to sex-differential selection pressures, without fully accounting for the possible impact of genetic constraints, such as intersexual genetic correlation or sex differences in heritability. Previous studies have published heritability estimates for dental traits in primates, but none have analyzed males and females separately. Using dental measurements from 302 pedigreed saddle-back tamarins (*Saguinus fuscicollis*), this study evaluates the assumption that tooth size heritabilities are similar in males and females of this species.

Analysis of two sexually dimorphic dental traits (C<sup>1</sup> height and P<sub>2</sub> length) and two monomorphic dental traits (I<sup>1</sup> length and M<sup>2</sup> length) demonstrates heritability estimates significantly greater

than zero in both sexes for I<sup>1</sup> length ( $h^2_M=0.565$ ,  $h^2_F=0.965$ ) and M<sup>2</sup> length ( $h^2_M=0.565$ ,  $h^2_F=0.524$ ), and in males for C<sup>1</sup> height ( $h^2_M=0.629$ ) and P<sub>2</sub> length ( $h^2_M=0.370$ ). Female heritability estimates for the sexually dimorphic dental traits were not significantly different from zero (C<sup>1</sup> height:  $h^2_F=0.211$ ,  $p>0.25$ ; P<sub>2</sub> length:  $h^2_F=0.184$ ,  $p>0.05$ ). Due to this sex difference in heritabilities, C<sup>1</sup> height and P<sub>2</sub> length are more evolvable in males than females of this population; sexual dimorphism in these traits could therefore result from genetic constraints, not sex differences in selection pressures. Similar genetic constraints may contribute to canine dimorphism in other primate species and should be accounted for when formulating evolutionary hypotheses.

### A new method for assessing postmortem DNA damage from ancient remains

KELLY M. HARKINS<sup>1,2</sup>, JOSHUA D. KAPP<sup>3</sup>, LARS FEHREN-SCHMITZ<sup>1</sup> and RICHARD E. GREEN<sup>2</sup>

<sup>1</sup>Anthropology, University of California Santa Cruz,

<sup>2</sup>Biomolecular Engineering, University of California Santa Cruz, <sup>3</sup>Ecology & Evolutionary Biology, University of California Santa Cruz

High-throughput sequencing (HTS) of DNA recovered from ancient remains is now a common approach in paleoanthropological and archaeological genetics. Over the past decade, this sequencing technology has allowed researchers to better identify and characterize the damage and degradation that is a hallmark feature of ancient DNA (aDNA). However, the process of library preparation – converting ancient DNA molecules recovered from remains into molecules suitable for HTS – often includes steps that obscure actual damage, especially at the ends of the molecules. Additionally, terminal damage may not always be repairable, rendering some authentic molecules inaccessible and thus not incorporated into the library. To better assay aDNA preservation, we have developed a method that retains and characterizes the otherwise lost patterns of terminal aDNA damage. We present a comparison of our method to standard ancient library preparations as applied to archaeological human and other remains from a range of time periods and preservation conditions. The new method allows us to characterize postmortem damage processes in a way that conventional library preparation methods cannot, which has implications for future paleogenetic work as HTS becomes more widely adopted.

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### Relative fibular strength and locomotor behavior in OH 35 and KNM-WT 15000

CHRISTINE M. HARPER<sup>1</sup>, DAMIANO MARCHI<sup>2,3</sup>, HABIBA CHIRCHIR<sup>4,5</sup> and CHRISTOPHER B. RUFF<sup>1</sup>

<sup>1</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>2</sup>Department of Biology, University of Pisa, <sup>3</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand, <sup>4</sup>Department of Biological Sciences, Marshall University, <sup>5</sup>Human Origins Program, National Museum of Natural History, Smithsonian Institution

Relative fibular/tibial strength has been demonstrated to be related to the degree of arboreality/terrestriality in anthropoid primates. In this study fibular/tibial strength was determined in OH 35, a *Homo habilis* (or possibly *Paranthropus boisei*), (1.8 myr) and KNM-WT 15000, a juvenile *Homo erectus*, (1.5 myr), and was compared to modern humans ( $n=79$ ), chimpanzees ( $n=16$ ), gorillas ( $n=16$ ) and orangutans ( $n=11$ ). Ontogenetic changes in fibular/tibial strength were also analyzed due to KNM-WT 15000's juvenile status. Cross-sectional properties were derived from multi-plane radiography and either CT sections of casts (fossils) or external molds (extant). RMA regressions were run on polar second moment of area (J), a measure of torsional and average bending rigidity, of the fibula against that of the tibia for all extant species. Fossils were analyzed using their relative deviations from each regression line, expressed in SEE units. Great apes differed significantly from humans in regression line elevation, with relatively stronger fibulae. OH 35 fell in the center of the great ape distribution, within 1 SEE of each great ape taxon, but 1.9 SEE from humans. KNM-WT 15000 was more than 2 SEE from all great apes and within 0.6 SEE of humans. This was not a result of his age, as fibular/tibial strength slightly decreases with age in humans. OH 35 has some human-like features; however, the relative strength of the two bones aligns the specimen with great apes, suggesting a significant degree of arboreality. KNM-WT 15000 is demonstrated to be fully modern, complimenting other evidence for complete terrestrial bipedality.

### The effect of different patterns of cranial vasculature on encephalization within Primates

ARIANNA R. HARRINGTON and DOUG M. BOYER

Department of Evolutionary Anthropology, Duke University

Though it is well known that patterns of cranial vascular supply are phylogenetically distinctive for groups of primates, few have considered the potential consequences of these differences for brain evolution. Here we test whether patterns of cranial vasculature are correlated with encephalization and evaluate the significance of our findings for certain fossils. We use cranial and

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vertebral arterial foramina radii measured in 53 taxa to estimate volumetric blood flow rates (Q) of the arteries they once carried—the internal carotid (ICA) and vertebral (VA) arteries, respectively—using published equations for hemodynamic flow. Ratios of QICA to QVA demonstrate an average of 0.515 (range: 0.060-1.748) for haplorhines, whereas strepsirrhines average at 0.008 (range: 0.003-0.020), confirming that the latter taxa predominantly receive encapalic blood from the VA compared to haplorhines. When log (QICA/QVA) was phylogenetically regressed against the encephalization quotient (EQ), a significant direct correlation emerged. Interestingly, the most encephalized haplorhine (*Homo*) and strepsirrhine (*Daubentonia*) also express the greatest carotid dominance (highest QICA/QVA) within their respective groups. The fossil adapiform taxa *Notharctus* and *Smilodectes*, while demonstrated to match haplorhines more than strepsirrhines when considering only ICA measurements, have a QICA/QVA ratio suggesting VA dominance, at 0.06 and 0.08, respectively. Their EQ's are also less than those of any modern haplorhines and are more similar to those of modern strepsirrhines. These data may suggest that emphasis of the ICA for encephalic blood flow contributed to the evolution of relatively larger brains within Primates.

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### Application and Accuracy of 3D Scanned Postcranial Bones

VICTORIA HARRINGTON and HEATHER MCKILLOP  
Geography and Anthropology, Louisiana State University

Three-dimensional technologies are infiltrating the scientific world, providing innovative and economical options to create sustainable research samples. Three-dimensional scanning of human remains demonstrates the potential to revolutionize analyses in osteological data collection and analysis. To ensure that 3D scanned remains are comparable between osteological studies, resolution and other standards must be explored. This research was designed to test the visual and metric accuracies of 3D scans using an economical, medium-range scanner (NextEngine®) at different resolutions and settings. Metric analyses were used to test if differences existed between the dry bone and the 3D scanned bone. High-resolution, mid-level resolution, and low-level resolution settings that require resolution-specific hardware and software resources were tested. To isolate those standards, a left hip bone from the excavated remains of an ancient Maya (AD 600-800) trading port from Moho Cay, Belize, was scanned at a range of settings. The remains were inundated

with sea-level rise, and although well-preserved, their exposure has made them fragile. Three-dimensional scanning allows for permanent, noninvasive preservation of these remains. Visual analyses noting gross morphology, rugosity, nonmetric variation, pathology, trauma, age, and sex were conducted. For metric analysis, five measurements were taken using sliding calipers and the 3D software Netfabb®. The visual analyses were evaluated for similarities. Mid-level settings were found to have the highest accuracy, at over 95% similarity. Metric analyses for high- and mid-level resolutions demonstrated options which produced comparable measurements.

### Insights into the Cahokian Sphere of Influence through Ancient DNA Evidence

JESSICA L. HARRISON and FREDERIKA A. KAESTLE  
Anthropology, Indiana University

Mississippian culture arose and spread rapidly from the city center of Cahokia, the largest pre-Columbian Eastern Woodlands polity, located near present-day St. Louis. This rapid cultural transmission has led to many theories about the degree and extent to which Cahokia exerted power upon outlying settlements ranging from little influence to complete replacement. Standard polymerase chain reaction (PCR) methods to target and amplify four overlapping fragments of approximately 150 base pairs in length were used to obtain the Mitochondrial HVSI haplotypes for 24 individuals. These individuals represent six separate burial features of varied ascribed status within the highly ceremonial Mound 72. Regional comparisons were made between Cahokia and other previously characterized archaeological sites using Admixture. The non-significant results suggest that the Mound 72 individuals were not biologically distinct from the other burial groups in the region. Interestingly, the analysis showed that the Mound 72 individuals were most similar to The Mississippian component of the Lower Illinois River Valley Schild burial group. This supports previous dental metric regional analyses that highlighted a similar relationship and posited a female-specific admixture between the two locales. Our results refute ideas of regional replacement from a center of power, but rather support that notion that lifeway changes in the region were a result of acculturation likely accelerated through increased intermarriage. Larger sample sizes, greater genomic coverage and finer statistical analyses will be required to better illuminate more detailed genetic relationships including male patterns, particularly as the region demonstrates overall low genetic variability.

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### What Biological Anthropology Can Teach Us about Conflict and Social Inequality: Teacher and Student Reflections

RYAN P. HARROD, NORMA M. JOHNSON, ASHLEY A. HANNIGAN and MEAGHAN A. KINCAID  
Anthropology, University of Alaska Anchorage

Conflict and social inequality are found in societies throughout the world, which makes researching and teaching about these behaviors vital to understanding the human experience. Biological anthropologists are well suited to address these issues in their courses, as physical manifestations of violence, both direct and structural, are written on the bodies of the living and the dead. This allows us to both identify the consequences and interpret the causes of personal and community violence in the past and the present. Using human skeletal remains, ethnohistoric accounts, and ethnography, the courses taught at the University of Alaska Anchorage, University of Nevada, Las Vegas, and the University of Massachusetts-Amherst challenge students to explore different pedagogical approaches to better understand why violence and inequality exist. Compiling data from the numerous student projects that have come out of these three universities, we highlight the ways biological anthropology offers insight into violence that other disciplines often cannot. Additionally, we explore how experiential learning in the courses provided students with the skills and knowledge necessary to continue to explore these concepts beyond the classroom. Many of the students have gone on to design and conduct their own research on conflict and social inequality at both the undergraduate- and graduate-level. Finally, we provide vignettes of how these courses change both student and teacher understanding of violence and its importance to modern issues.

### Functional adaptations of primate forearm and leg muscle fiber architecture

ADAM HARTSTONE-ROSE<sup>1,2</sup>, CARISSA L. LEISCHNER<sup>1,2</sup>, FRANCISCO PASTOR<sup>3</sup> and DAMIANO MARCHI<sup>4,5</sup>

<sup>1</sup>Cell Biology and Anatomy, University of South Carolina School of Medicine, <sup>2</sup>Anthropology, University of South Carolina School of Medicine, <sup>3</sup>Departamento de Anatomía y Radiología, Universidad de Valladolid, <sup>4</sup>Department of Biology, University of Pisa, <sup>5</sup>Evolutionary Studies Institute, University of the Witwatersrand

The osteology of the fore- and hind-limbs has been correlated with locomotion, posture and substrate use in primates, but less attention has been paid to myological adaptations. Previously we presented data on the functional correlates of primate forearm muscle fiber architecture variables: fascicle length (FL), physiological cross-sectional area (PCSA) and reduced PCSA (RPCSA). Here, we greatly expand the

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sample to include 9 strepsirrhine, 15 platyrrhine, and 20 catarrhine taxa spanning the entire size range of the order (*Microcebus* to *Gorilla*), and we also include fiber data from the leg.

Forearm muscle mass scales with positive allometry across all primates. Catarrhines exhibit positive allometry in their PCSA and RPCSA indicating that larger catarrhines have relatively stronger forearm muscles. While PCSA and RPCSA scale with isometry for terrestrial species, they scale with positive allometry for arboreal ones – thus larger arboreal primates have relatively stronger forearms. Surprisingly, there are no differences in the forearm architecture of quadrupeds (QUAD) when compared to vertical clinging and leaping/suspensory species (VCL).

All leg strength variables (mass, PCSA, RPCSA) scale with positive allometry, and speed/stretch measure (FL) scales with isometry across the sample. Thus, larger primates are relatively stronger though not more flexible/faster. There is no other phylogenetic signal in the leg muscles. Arboreal primates have greater leg RPCSA and QUAD have statistically heavier leg muscles than VCL, though they are not greater in cross-sectional area or reduced in FL.

Thus, postural and substrate use adaptations in strength and speed substantially differ between the fore- and hind-limbs.

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### Problems in Predicting Anatomy and Inferring Behavior from the Gross Morphology of the Flexor Pollicis Longus Insertion Site

KEVIN G. HATALA<sup>1,2</sup>, ERIN MARIE WILLIAMS-HATALA<sup>1,2</sup>, TERESA SCIBILIA<sup>1</sup>, SHANNON HILES<sup>1</sup> and KARYNE N. RABEY<sup>3</sup>

<sup>1</sup>Department of Biology, Chatham University, <sup>2</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University, <sup>3</sup>Department of Anatomy, Midwestern University

The morphology of the insertion site for the flexor pollicis longus (FPL) muscle is frequently used by paleoanthropologists to infer the soft tissue anatomies of hominin thumbs and, subsequently, to develop behavioral hypotheses for particular fossils or even entire taxa. Such inferences rely on presumed correlations between the morphology of the FPL attachment and the anatomy/function of the FPL muscle. However, the validity of this assumption is uncertain. Using FPL architecture and morphologies of associated insertion sites from 20 cadaveric human specimens, we assessed the strengths of the relationships between the two, and created a series of predictive models as an experiment to evaluate the accuracy of predicting FPL anatomy from its insertion site morphology.

We found that all measured variables related to FPL architecture (PCSA, muscle mass, fiber length, length of the muscle-tendon unit) were weakly correlated with the gross morphology of the FPL insertion site (entheses height, width, area and rugosity;  $p > 0.05$  for all combinations). Next, we built sets of linear regression models to predict the FPL muscle variables from the FPL insertion measurements. Each model's predictive accuracy was assessed using an iterative leave-one-out approach, calculating the root mean squared error of predicting each observation from the other 19. In all cases, average prediction errors exceeded standard deviations of the dependent variables, demonstrating the futility of these models. This result adds to a growing body of literature that cautions against the use of gross morphologies of muscle attachment sites to draw anatomical, behavioral, or evolutionary inferences.

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### Explaining distinct crania from Colonial Delaware using craniometric and genetic analyses

KATHLEEN A. HAUTHER<sup>1</sup>, ASHLEY H. MCKEOWN<sup>2</sup>, MERADETH SNOW<sup>3</sup> and M. K. SPRADLEY<sup>2</sup>

<sup>1</sup>Anthropology, University of Tennessee, Knoxville,

<sup>2</sup>Anthropology, Texas State University, San Marcos,

<sup>3</sup>Anthropology, University of Montana

Craniometric data from unknown individuals can be compared to known reference populations to estimate ancestry, and discriminant functions analysis is commonly used for this task (Jantz and Ousley 2005, 2013). However, if an appropriate reference population is not included in analysis, the unknown will still classify into a group (Jantz and Ousley 2013). Even if the correct ancestry group is present for comparison, the unknown individual may still be misclassified if temporal discontinuity exists due to secular change of the populations' crania (Angel 1982). Individuals of European descent from Colonial American sites are sometimes misclassified as individuals of African ancestry, due to the use of inappropriate reference samples not contemporary to the unknown (Angel 1976). This study provides a comparison of cranial morphology between individuals from a Colonial era site in Delaware (Elkins site) to several reference populations: 19<sup>th</sup> century Africans, 18<sup>th</sup>-19<sup>th</sup> century African-Americans, and 17<sup>th</sup>-18<sup>th</sup> century Europeans, as well as modern 20<sup>th</sup> century American blacks and American whites, to explore the effect of secular change on ancestry estimation. Craniometric analyses show the Colonial era individuals classify as American black when compared to modern reference populations, yet classify as European when compared to contemporary reference populations. Analysis of mitochondrial DNA demonstrated European maternal lineages

for these individuals. The combined craniometric and genetic analyses demonstrate the need to use temporally appropriate reference populations for ancestry estimation due to the implications of secular change.

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### Stature Estimation from the Calcaneus and Talus in Japanese Individuals

ATSUKO HAYASHI<sup>1</sup>, PAUL D. EMANOVSKY<sup>2</sup> and THOMAS D. HOLLAND<sup>2</sup>

<sup>1</sup>Social Welfare and War Victims' Relief Bureau, Ministry of Health, Labour and Welfare in Japan,

<sup>2</sup>Department of Defense, Defense POW/MIA Accounting Agency

Currently, estimating stature using the calcaneus and talus in Japanese individuals is unavailable. This study examined the findings of Holland ([1995] *Am. J. Phys. Anthropol.* 96:315-320) as applied to a small stature group of Japanese born between 1855 and 1929. Total sample size involved 261 pairs of calcani and tali from African and European American individuals from the Hamann-Todd Human Osteological Collection and the William M. Bass Donated Skeletal Collection, and 103 Japanese individuals from the University of Chiba School of Medicine and Jikei University School of Medicine in Japan. The estimates of Japanese living stature were obtained from equation (1) in Hayashi et al. ([2016] *J. Forensic Sci.* 61:415-423) due to lack of living stature records. Five independent variables: maximum lengths of calcaneus and talus, and posterior length of calcaneus, summed lengths of maximum length of calcaneus and talus, and summed posterior length of calcaneus and maximum length of talus, are used to formulate equations after assessment of the Variance of Inflation Factor. Bias and accuracy tests in this validation study indicates that it is not necessary to use group-specific equations for all three groups, however maximum length of talus should use from the group-specific equations. The benefit of the result indicates forensic practitioners have a viable alternative standard error estimate including small statures of Japanese individuals without assessing ancestry. If the remains are known to be Japanese, then only talus is available, the group-specific equation should be used.

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### Remoteness Influences Access to Sexual Partners and Drives Patterns of Viral Sexually Transmitted Disease Prevalence among Nomadic Pastoralists

ASHLEY HAZEL<sup>1,2</sup> and JAMES HOLLAND JONES<sup>1,2,3</sup>

<sup>1</sup>Earth System Sciences, Stanford University, <sup>2</sup>Woods Institute for the Environment, Stanford University,

<sup>3</sup>Department of Life Sciences, Imperial College London

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While much is known about the importance of migration for the spread and importation of infectious diseases through new exposure contacts, little attention has been paid to the role of contact structure on epidemic amplification. Carnegie & Morris (2012) showed that small populations with high levels of sexual-partner concurrency yield densely connected networks, allowing for rapid transmission of STIs. In many subsistence-based sub-Saharan African communities, these two underlying features—dense rural connectivity and contact bridging between communities—may be ominously at play. Using disease status data (herpes simplex virus (HSV)-specific antibodies) and sexual contact-network data from our ongoing research with the Himba pastoralists in Kaokoveld Namibia, we built a series of log-linear models that demonstrate that functional remoteness of residency is significantly associated with a higher likelihood of having sexual partners from the same area of residence ( $p < 0.001$  for model) and higher local HSV prevalence ( $p = 0.005$ ). The regions of Kaokoveld that were less functionally remote (i.e. people were more likely to travel to areas outside their region of residence) also had lower degrees of partner homophily, indicating that, when not limited by geographic remoteness, people in this community acquired partners from regions other than their own. At the time these data were collected (2009), non-homophilous partners were selected from the same set of related tribal groups; however, long-term alterations in subsistence behavior in response to climate-change induced drought may increase contact with new communities, resulting in networks with structures for both disease importation and disease amplification.

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### Ontogenetic Changes and Adult Variation in Human Metatarsal Torsion

AMBER N. HEARD-BOOTH<sup>1</sup> and ADDISON D. KEMP<sup>2</sup>

<sup>1</sup>College of Human Medicine, Michigan State University, <sup>2</sup>Department of Anthropology, University of Texas at Austin

Humans exhibit little torsion of their medial metatarsals (MT1-2) and a high degree of torsion (eversion) of their lateral metatarsals (MT3-5). This pattern of torsion is unique among primates and is possibly related to the presence of the longitudinal arch. Currently, we know little about how metatarsal torsion develops throughout ontogeny, or the range of variation in torsion among adults. Here, we investigate ontogenetic and inter-individual variation in metatarsal torsion in two archaeological populations.

We used a MicroScribe-G2X to digitize 4 landmarks of the metatarsal, including points on the dorsal- and plantar-most mid-points of the

proximal and distal ends. Data were collected on metatarsals 1-4 belonging to individuals of the Mis Island Nubian (ca.500-1400AD; N=172) and Norris Farms Oneota (ca.1300AD; N=58) populations. We used a custom R script to calculate torsion as the angle enclosed between lines bisecting the dorso-plantar mid-points of the proximal and distal ends. Individuals were grouped into age-range categories for ontogenetic analyses (2-6yrs, 6-12yrs, 12-20yrs, 20+yrs), and population-level differences in torsion were also investigated.

We found that the mean torsion values of MT2, MT3, and MT4 increase with age, but differences between age categories for a given element were not statistically significant. Population-level comparisons revealed that individuals from Mis Island have significantly greater torsion of MT2 ( $p < 0.001$ ) and MT3 ( $p < 0.001$ ) than those from Norris Farms. Therefore, if greater torsion of MT3 is related to the height of the longitudinal arch, this result suggests that the Nubians had feet with higher arches than the Oneota.

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### The ontogeny of manipulation complexity within 26 primate species

SANDRA A. HELDSTAB, JUDITH M. BURKART, CAREL P. VAN SCHAİK and KARIN ISLER

Department of Anthropology, University of Zurich

Studying the ontogeny of complex food manipulations in primates facilitates our understanding of phenotypic plasticity and cognitive abilities in primates as well as the emergence of tool use in humans. Here, we assess whether the interspecific order of the complexity scale assigned in a previous study of adults in 37 primate species matches the order of emergence of these manipulation categories during ontogeny. We examined the developmental trajectory of manipulation complexity longitudinally and cross-sectionally based on over 10'000 object manipulation and 90 tool use bouts in 131 individuals of 26 primate species. Although individual and species variation in the timing of appearance and frequency of use of different manipulative skills was substantial, the order of emergence of the manipulative categories during ontogeny was consistent within all primate species and followed the interspecific order of the complexity scale. Thus, ontogeny recapitulated phylogeny. First, individuals developed unimanual grasping of a single object with synchronized digits followed by bimanual manipulations with synchronous digits and hands. Later, the capability to perform actions with synchronous digits and asynchronous hands emerged. Next, unimanual actions with asynchronous digits preceded bimanual actions with asynchronous digits. Multiple-object manipulations emerged last. Overall, most individuals reached

adult-level manipulation complexity before or at weaning, although adult-level success in the more complex manipulations emerged later.

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### Quinticeps? Investigating a Possible Fifth Head of the Quadriceps femoris in Non-human Primates

HOLDEN W. HEMINGWAY<sup>1</sup> and MAGDALENA N. MUCHLINSKI<sup>2</sup>

<sup>1</sup>Department of Anatomy and Neurobiology, University of Kentucky, <sup>2</sup>Center of Anatomical Science, University of North Texas

Variation within humans' quadriceps muscles, specifically the musculature adjacent to the vastus lateralis (VL), has long been reported. Recently, it has been proposed that the widely reported variation in the VL is due to a fifth, distinct muscle between the vastus lateralis and vastus intermedius named the tensor of the vastus intermedius (TVI). Two functions of the TVI were proposed: 1) it has significant control of the drive of the patella and 2) it modifies the action of the vastus intermedius, a muscle that is important in stabilizing the patella during extension at the knee. Our investigation aimed to examine if the TVI was present in non-human primates and to identify any correlation with TVI and locomotion. We hypothesized that vertical clingers and leapers would have a TVI similar to humans. Our sample included 24 non-human primate species that ranged in body size. We included all locomotor styles. In all but 2 of the 27 specimens, the TVI was identified in the same location as reported in humans, but was dissimilar to how it was otherwise described in humans. We found no correlation between TVI anatomy and locomotion. Vertical clingers and leapers did not have a variation in TVI that was specific to them. The TVI was found in 22 non-human primate species, although it differed greatly from its description in humans. Based strictly on TVI's attachments, we found no evidence that TVI acts to stabilize the patella in non-human primates.

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### Historic era immigrants to northern Pakistan? A dental morphology investigation of Pathans, Gujars and Kohistanis

INAM ULLAH<sup>1</sup>, HABIB AHMAD<sup>2</sup> and BRIAN E. HEMPHILL<sup>3</sup>

<sup>1</sup>Dept. of Genetics, Hazara University, <sup>2</sup>Vice-Chancellor's Office, Islamia College, <sup>3</sup>Dept. of Anthropology, University of Alaska, Fairbanks

The biological affinities of ethnic groups residing in northern Pakistan remain largely unknown. Historical records suggest Pathans are immigrants from Afghanistan, while Gujars are immigrants from the Indus Valley. This study

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employs 14 tooth-trait combinations of the Arizona State University Dental Morphology System among 823 individuals of five ethnic groups (Gujars, Kohistanis, Yousafzais, Tharkalanis, Uthmankeils) from Dir and Swat Districts, the latter three of which self-identify as Pathans. These data were contrasted with 27 samples encompassing 3,185 prehistoric and living individuals from Pakistan, peninsular India, and Central Asia. Intersample affinities based upon pairwise MMD values were examined with neighbor-joining cluster analysis (NJ), multidimensional scaling (MDS), and principal component analysis (PCA).

Results vary by data reduction technique. NJ identifies Gujars, Kohistanis and Uthmankeils as possessing affinities to the ancient Harappans of the Indus Valley, Yousafzais as having affinities to ethnic groups of the Hindu Kush-Karakoram highlands, while Tharkalanis exhibit no close affinities. MDS identifies the Pathan groups as having closest affinities to one another, with Kohistanis somewhat removed and Gujars aligning with the ancient Harappans, while PCA identifies Kohistanis, Yousafzais, and Gujars possessing affinities to one another. The results suggest: 1) immigrant Pathan groups were small in number and intermarried extensively with local groups, especially those occupying the highlands; 2) Kohistanis are not closely related to these immigrants; and 3) affinities of Gujars attest to their Indus Valley origins.

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### Rapid Evolution of Lighter Skin Pigmentation in Southern Africa

BRENNA M. HENN<sup>1</sup>, MENG LIN<sup>1</sup>, ALICIA R. MARTIN<sup>2</sup> and REBECCA SIFORD<sup>1</sup>

<sup>1</sup>Ecology and Evolution, Stony Brook University,

<sup>2</sup>Analytic and Translational Genetics Unit, Department of Medicine, Massachusetts General Hospital and Harvard Medical School, Boston

Skin pigmentation is under strong directional selection for reduced melanin density in northern European and Asian populations. Conversely, dark pigmentation is thought to be under stabilizing selection in equatorial populations exposed to intense ultraviolet radiation. We high-throughput sequenced pigmentation genes in over 400 individuals from South Africa and demonstrate that a canonical skin pigmentation gene, SLC24A5, experienced recent adaptive evolution in the KhoeSan populations of far southern Africa. The functionally caustive allele lightens basal skin pigmentation by 4 melanin units, explaining 11.9% variance in pigmentation in these populations. Haplotype analysis and demographic models indicate that the allele was introduced into the KhoeSan only within the past 3,000 years likely by eastern African pastoralists. The

most common haplotype is shared among the KhoeSan, eastern Africans and Europeans but has risen to a frequency of 25%, far greater than expected given initial gene flow. The SLC24A5 locus is a rare example of strong, ongoing adaptation in very recent human history.

### Can Small be All? The Limited Commonalities of Mata Menge and Liang Bua Hominins on Flores

MACIEJ HENNEBERG<sup>1</sup>, ADAM J. KUPERAVAGE<sup>2</sup>, SAKDAPONG CHAVANAVES<sup>3</sup> and ROBERT B. ECKHARDT<sup>3</sup>

<sup>1</sup>Adelaide Medical School, The University of Adelaide,

<sup>2</sup>Department of Public and Allied Health Sciences, Delaware State University, <sup>3</sup>Laboratory for the Comparative Study of Morphology, Mechanics, and Molecules Department of Kinesiology, Pennsylvania State University

The original diagnosis of “*Homo floresiensis*” from the Liang Bua skeletal remains listed among numerous others these defining elements: Small-bodied; endocranial volume similar to, or smaller than, *Australopithecus africanus*; lacks masticatory adaptations present in *Australopithecus* and *Paranthropus*; first and second molar teeth of similar size; mandibular coronoid process higher than condyle; mandible without chin. We already have shown in 2015 that these and many additional defining elements largely are those of the LB1 individual, since most LB specimens are represented by only one or two bones each. Even some of the few duplicated elements differ: The LB6 mandibular ramus is shorter than that of LB1 and lacks a coronoid higher than condyloid process. Statures originally were under-estimated and are matched in regional extant small bodied humans, as are small, chinless mandibles. The Mata Menge (0.7 Ma) gnathic specimens include a fragment of mandibular corpus (SOA-MM 4) plus six teeth. These establish little other than small size within the already known human range. For example, SOA-MM1 shows uncorrected dimensions of 9.7 mm MD x 8.9 mm BL, close to Klasies River Mouth KRM14624 (9.3x8.8) and KRM43110 (10.2x9.1). Given the extremely limited Flores skeletal evidence, and the known unreliable correlations of body and brain size with tooth sizes, it is premature to suggest that the Mata Menge gnathic fragments establish any more than previously known archaeological evidence: the existence of hominins of as yet indeterminable taxonomic status on an island where *Homo sapiens* is known to have a living and archeological presence.

### Isotopic and paleopathological analysis of Pre-Columbian secondary interments at Cueva Vigía, Sancti Spiritus, Cuba.

MAURICIO HERNANDEZ<sup>1</sup>, ARMANDO RANGEL RIVERO<sup>2</sup>, and DODANY MACHADO MENDOZA<sup>3</sup> <sup>1</sup>University of California Los Angeles – USA; <sup>2</sup>Museo Montané, University of Havana – Cuba; <sup>3</sup>Instituto de Medicina Legal – Cuba

MAURICIO HERNANDEZ<sup>1</sup>, ARMANDO RANGEL RIVERO<sup>2</sup> and DODANY MACHADO MENDOZA<sup>3</sup>

<sup>1</sup>UCLA Extension, University of California, Los Angeles, <sup>2</sup>Museo Montané, University of Havana,

<sup>3</sup>Instituto de Medicina Legal, Havana, Cuba

The purpose of our study is to explore dietary and burial practices of Pre-Columbian communities to gain a better understanding of population dynamics in the earliest settled island of the Caribbean. Cueva Vigía is karstic cave located at coordinates N 22°16'871", W 79°10'12.652" on the Bamburanao ridge, running NW to SE along Northern Central Cuba. Between 2011 and 2013, several intentionally positioned human remains were found near the mouth of the cave, suggesting it may have served as a ceremonial rather than a residential space. Preliminary osteological assessments indicate the assemblage, which suffered weathering and moderate taphonomic damage, is composed of three subadults and five adults of indeterminate sex. Four skeletal and dental fragments were dated to between 1565-1600 + 15 BP, indicating the burials likely belong to the Ciboney, or “cave-dwelling people” in the Arawak language.

Carbon and nitrogen isotopic signatures from four samples point to a generalist diet with equal marine, riverine, and terrestrial components, suggesting frequent travel or trade with the northern coast situated 11km away. Although these individuals had an iron-rich diet, macroscopic analyses found evidence for active porotic hyperostosis in three adult cranial fragments, pit-form defects on a permanent molar, and multiple linear enamel hypoplasias on anterior dentition. This phenomenon may be the result of exposure to fish-borne parasites and high nutrient loss via diarrheal disease. Our research provides essential data on Ciboney nutrition and mortuary customs to track the timing of socio-cultural evolution across the Greater Antilles.

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### Spider monkeys and the functional ecology of olfactory sensitivities to alcohol

LAURA HERNANDEZ-SALAZAR<sup>1</sup> and MATTHIAS LASKA<sup>2</sup>

<sup>1</sup>BIOLOGIA DE LA CONDUCTA, INSTITUTO DE

NEUROETOLOGIA, UNIVERSIDAD VERACRUZANA,

<sup>2</sup>BIOLOGY, UNIVERSITY OF LINKOPING

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The interpretation of neuroanatomical features in primates placed them as microsmatic animals. Whereas physiological evidence of a poorly developed sense of smell in this order of mammals is largely lacking. Using a food-rewarded two choice instrumental conditioning paradigm, we assessed the olfactory sensitivity of spider monkeys for aliphatic alcohols (ethanol to 1-octanol), because this class of substance is presumed to indicate a fruit's degree of ripeness, and for "Green odors", a group of substances composed by  $C_6$  alcohol, the "Green odors" are known to exert anxiolytic and stress-reducing effects, and are widely present in the vegetative parts of a wide variety of plants, and thus likely to be behaviourally relevant for frugivorous primates. For aliphatic alcohols, the spider monkeys (with exception of 1-propanol) significantly discriminated concentrations below 1 ppm from the odorless solvent, and in several cases, individual monkeys even demonstrated detection thresholds below 10 ppb, and for the alcohols related to "Green odors" the spider monkeys were found to detect the stimuli at concentrations below 1 ppm, being affected by the configuration of the odorant molecules. Taken together the results showed that spider monkeys have a well-developed olfactory sensitivity for the majority of alcohols tested (compared with other mammals, including humans). These findings lend further support to the growing body of evidence suggesting that between-species comparisons of the number of functional olfactory receptor genes or of neuroanatomical features are poor predictors of olfactory performance.

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### Finding the Volume of the Femoral Intercondylar Fossa from a 3D Scanning Image Using CAD Modeling Software

BRIANNA E. HERNDON and SARA K. BECKER

Department of Anthropology, University of California, Riverside

Previous studies have indicated a relationship between distal femoral fossa morphology and proclivity to non-contact anterior cruciate ligament (ACL) injury. Available studies utilize linear landmark measurements, such as femoral bicondylar width and notch width, to quantify notch morphology. In an effort to provide more accurate representation of notch morphology and subsequent data analyses, a 3D Systems Sense 2<sup>nd</sup> Generation hand scanner was used to create digital models of the distal femur for 44 individuals from three Tiwanaku collections (M1, M10, and M70), housed at the Museo Contisuyo in Moquegua, Peru. This research focuses on the methodology and protocol developed to manipulate and retrieve quantifiable data from the scans generated with this 3D modelling, via a new application with CAD (computer-aided

design) programs. CAD processing of 3D models can compute the volumes of delineated objects as well as empty space, such as the volume of space contained between the femoral condyles. As opposed to a 2D image, a 3D model and CAD processing allows us a more dynamic and accurate method for investigating how movement shapes bone physiology, which can play a large role in injury prevention programs. In addition to the CAD program that calculates volume, other foreseen uses of this 3D scanner are calculating ceramic sherd volumes or modeling in paleopathology, as well as 3D printing accurate replicas for teaching purposes. The scanner is affordable, easily portable, and captures a large amount of detail, making it, and the developed processing protocol of the generated image, useful across many disciplines.

### Comparative Sub-Regional Population Structure within South America using MtDNA and Y-Chromosome DNA

BRIANNE C. HERRERA<sup>1</sup> and MARK HUBBE<sup>1,2</sup>

<sup>1</sup>Anthropology, Ohio State University, <sup>2</sup>Instituto de Arqueología y Antropología, Universidad Católica del Norte, Chile

The genetic structure of South America has primarily been explored in the context of human dispersion patterns into the Americas, with the assumption that the local environment does not significantly affect the continental apportionment of between-population genetic variation. To explore the impact of environment on regional genetic structure, we calculated correlations between mtDNA haplogroups of 50 South American populations from 5 macro-regions, linear geographic distances, and five climatic variables (mean annual temperature, annual temperature range, annual precipitation, isothermality, and altitude). The same analysis was performed using Y-chromosome STR frequencies from 35 South American populations. While mtDNA shows some structure in relation to climate, Y-chromosome DNA does not. Mantel tests and Partial Mantel tests correcting for geographic distance were performed for each region independently. When looking all populations in South America, there is a significant geographic signal from mtDNA ( $r=0.17$ ,  $p=0.004$ ) and no correlation with climate variables. Y-chromosome DNA, however, shows no geographic signal ( $r=0.007$ ,  $p=0.425$ ) or correlation to climatic variables. This pattern varies considerably for mtDNA when South America is broken down into regions. A nonmetric MDS analysis shows a strong East - West division in the continent, with the Andes being the geographic divider. Y-chromosome DNA does not show any geographic clustering from the MDS analysis. These results suggest that local environmental conditions play a differential role in the apportionment of mtDNA and Y-chromosome variation in

the continent, possibly affecting the rate of drift and gene flow between and within groups.

### The Impact of Fossil Data on Inferences of Lemur Biogeographic History

JAMES P. HERRERA

Department of Mammalogy and Division of Vertebrate Paleontology, American Museum of Natural History

Biogeographic processes, including vicariance, dispersal, extinction, and founder event speciation, are the primary modes of geographic range evolution. Madagascar is renowned for its diverse endemic biota, but the evolutionary processes responsible for that diversity are unclear. Lemurs most likely dispersed to Madagascar, and the phylogeographic patterns of extant lemurs on Madagascar suggest the wet east and the dry west are divided by the central plateau, which is considered a significant dispersal barrier. The roles of biogeographic processes on Madagascar have not been compared empirically. With a near-complete phylogeny of living and extinct lemurs ( $n=110$  species), I used likelihood-based biogeographic models to compare the importance of vicariance, dispersal, sympatry, founder event speciation, and extinction in shaping species distributions. The results suggest that dispersal and founder-event speciation were important processes explaining species distributions on the island; species dispersed to regions outside the ancestral range at cladogenesis. High frequencies of dispersal and founder events were inferred between the east and west, especially through the central plateau. When fossil data were removed, however, the central plateau did appear to be a dispersal barrier. The results suggest riverine dispersal barriers may have reduced dispersal between the north and south more than the central plateau separated wet east versus dry west. This is the first study on all lemurs to test which biogeographic processes have shaped the evolution of regional diversity, with the results suggesting frequent dispersal as well as the important pre-Holocene role of the central plateau.

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### Historical Bioarchaeology and DVI: Data Integration of the Mississippi State Asylum Burial Sample and Archival Records

NICHOLAS P. HERRMANN<sup>1</sup>, MICHELLE L. DAVENPORT<sup>2</sup>, AMBER M. PLEMONS<sup>3</sup>, GRANT L. HARLEY<sup>4</sup>, AUDREY D. SHAEFER<sup>1</sup> and MOLLY K. ZUCKERMAN<sup>2</sup>

<sup>1</sup>Department of Anthropology, Texas State University, <sup>2</sup>Department of Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>3</sup>Department of Anthropology, Michigan State University,

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<sup>4</sup>Department of Geography and Geology, University of Southern Mississippi

The Mississippi State Asylum (MSA) Cemetery sample offers a complex opportunity to assess institutional health patterns in post-reconstruction Mississippi. Although the burials are unidentified, they are not unknown. Extensive admission, discharge, and death certificate records provide a layered demographic picture of the asylum community. These records provide a listing of most individuals who died at the facility (N≈10,000) and serve as the ante-mortem dataset within a Disaster Victims Identification (DVI) framework for the unidentified recovered burials (n=66). Employing dendrochronology, skeletal biology profiles, and isotopic geochemistry we assess the MSA sample within a DVI model. Identification is the ultimate goal, but an ancillary goal is to contextualize the limited burial sample. Candidate patient lists are derived from the DVI model based on biological profile and additional isotopic and archaeological information. From individual burial candidate lists, health profiles will be generated from the admission and death records and used to build a composite health picture of the burial sample in relation to the historical records. We present the results for Burial 1 for whom we have a dendrochronological coffin date of post-1926 (near cut), a dental enamel strontium ratio value of  $0.709253 \pm 0.000001$  2se, and dental enamel carbonate  $\delta^{18}O$  value of  $-4.13\%$  (VPDB). Combining these data with a biological profile, we narrow the potential patient list. Ideally, these efforts would lead to identification when combined with DNA analysis, but the candidate lists can also be examined to provide a richer understanding of the health challenges facing this institutionalized population.

### Influence of anatomical, cognitive, and behavioral variables on the morphological variation of human corpus callosum

YANN HEUZÉ<sup>1</sup>, NATHALIE TZOURIO-MAZOYER<sup>2</sup>, EMMANUEL MELLET<sup>2</sup> and FABRICE CRIVELLO<sup>2</sup>

<sup>1</sup>Univ. Bordeaux, CNRS, MCC, PACEA, UMR 5199, Bordeaux Archaeological Sciences Cluster of Excellence, France, <sup>2</sup>Univ. Bordeaux, CNRS, CEA, Neurodegenerative Diseases Institute, UMR 5293, Neurofunctional Imaging group, France

Identifying explanatory inter-individual variability of the anatomical structures involved in complex cerebral functions characterized by hemispheric specialization such as language represents a challenge and potentially offers the possibility to study how such functions appeared throughout human evolution. Corpus callosum (CC) plays a central role in the interhemispheric transfer of information and as such is a key structure to investigate. CC morphological variation of 452 adult volunteers (232 females, 220 males; 204 left handers (LH), 248 right handers (RH)) from the BIL&GIN database was quantified using

geometric morphometrics. Our results indicated that larger brains tend to have a relatively smaller CC ( $R^2=0.000596$ ,  $p<0.0001$ ). CC size explained 2.8% of callosal shape variation ( $p<0.0001$ ). The principal components analysis (PCA) of the Procrustes coordinates revealed a high level of callosal morphological variation and a moderate pattern of integration. There was a significant sexual dimorphism of CC ( $d=1.37$ ,  $p<0.0001$ ) with female CC displaying a thinner and flatter body, a relatively larger splenium, and a less rotated rostrum. No significant differences in callosal shape of RH vs. LH was found, even when correcting for the hemispheric dominance for language. Extreme negative scores on PC1 were represented by RH characterized by a smaller manual lateralization score (Edinburgh handedness inventory) ( $p=0.0014$ ). PC3, for which CC size explained 21% of shape variation, was significantly positively correlated with visuo-spatial abilities ( $p=0.02$ ) while no correlation between callosal shape and language components scores was evidenced. The most posterior section of CC constituted by visual fibers was one of the most morphologically variable.

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### Spatial Organization in Female Bonobos (*Pan paniscus*) Reflects Social Cohesion

ALEXANA J. HICKMOTT, COLIN M. BRAND, KLAREE J. BOOSE and FRANCES J. WHITE

Anthropology, University of Oregon

Female bonobos leave their natal community as nulliparous older adolescents or young adults. These immigrating females are peripheral and not immediately accepted into the core of the community. We examined focal and interaction data collected over 242 hours of observation at N'deli, Lomako Forest, DRC. We compared nearest neighbor patterns of one immigrant female into the Eyengo community compared to four resident Eyengo females. Three resident females were fertile and had infants while one post-menopausal resident female displayed no change in swelling during the study period and was presumed infertile. The females differed in proximity to male versus female nearest neighbors (Test of Independence  $G = 99.680$ ,  $P < 0.001$ ). The fertile resident females were not significantly different to each other in their sex-based proximity pattern (Non-significant subset  $G = 6.194$ , ns) and showed higher proximity to other females (average 80.1% of focal sampling). The immigrating female always had a male nearest neighbor and her proximity pattern was not significantly different to the post-menopausal resident female (Non-significant subset  $G = 6.600$ , ns). The immigrating female groomed and mated with three community males. Socially bonded females form core of bonobo communities while immigrating females must be accepted

into that core before they are considered resident in a community. Before acceptance, females are the focus of community males and lack female allies important for defense against male harassment. These data show the peripheral nature of immigration and the peripheralization that occurs with aging.

### The human voice conveys information on developmental stability

ALEXANDER K. HILL<sup>1</sup>, RODRIGO A. CÁRDENAS<sup>2</sup>, JOHN R. WHEATLEY<sup>3</sup>, LISA L.M. WELLING<sup>4</sup>, ROBERT P. BURRISS<sup>5</sup>, PETER CLAES<sup>6</sup>, COREN L. APICELLA<sup>7</sup>, MICHAEL A. MCDANIEL<sup>8</sup>, ANTHONY C. LITTLE<sup>9</sup>, MARK D. SHRIVER<sup>9</sup> and DAVID A. PUTS<sup>10,3</sup>

<sup>1</sup>Department of Anthropology, University of Washington, <sup>2</sup>Department of Psychology, The Pennsylvania State University, <sup>3</sup>Department of Anthropology, The Pennsylvania State University, <sup>4</sup>Department of Psychology, Oakland University, <sup>5</sup>Department of Psychology, Northumbria University, <sup>6</sup>ESAT/PSI – UZ Leuven, MIRC – iMinds, Medical IT Department, KU Leuven, <sup>7</sup>Department of Psychology, University of Pennsylvania, <sup>8</sup>Department of Management, Virginia Commonwealth University, <sup>9</sup>School of Natural Sciences, University of Stirling, <sup>10</sup>Center for Brain, Behavior, and Cognition, The Pennsylvania State University

Vocal communication is a salient feature of human social behavior that has increasingly been brought within the purview of sexual selection. Vocal cues may provide information to potential mates on vocalizers' developmental stability, which can be measured from fluctuating asymmetry (FA), anatomical deviations from perfect bilateral symmetry thought to inversely index the fit between genotype and environment. In humans, FA is negatively related to facial and olfactory attractiveness. Although two studies have found negative relationships between FA and vocal attractiveness, conclusions of species-typicality are premature in light of variable methodologies applied to small, homogeneous samples. In the present research, we conducted three studies comprising an appreciably larger sample than has been used previously (231 men and 240 women). We sampled US undergraduates as well as Tanzanian foragers less buffered from developmental stressors by evolutionarily novel medical technologies, and computed FA from both two-dimensional and, for a subset of males, three-dimensional facial imagery. Voice recordings were assessed for attractiveness. Meta-analytic results across the present samples plus those used in both prior publications, yielded weighted mean correlations between FA and vocal attractiveness of  $-.23$  and  $-.29$  for males and females, respectively (both  $p < .001$ ). Moreover, these results were robust and statistically significant whether we included effect sizes from previously published work, or only those from the present research, and regardless of the inclusion of any individual sample or

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method of assessing FA (e.g., facial or limb FA), thus providing strong support that the voice conveys information on developmental stability in humans.

*This work was supported by the National Institutes of Mental Health, the National Science Foundation, and by The Pennsylvania State University and Harvard University.*

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### **An analysis of upper and lower limb cross-sectional properties in the Lake Nitchie skeleton from southwestern New South Wales, Australia**

ETHAN C. HILL<sup>1</sup>, OSBJORN M. PEARSON<sup>1</sup> and ARTHUR C. DURBAND<sup>2,3,4</sup>

<sup>1</sup>Anthropology, University of New Mexico, <sup>2</sup>Sociology, Anthropology, and Social Work, Kansas State University, <sup>3</sup>Research Centre for Human Evolution, Griffith University, <sup>4</sup>Anthropology, Science Centre, South Australian Museum

The Lake Nitchie skeleton (~6800 bp) was discovered in the Murray Basin of New South Wales, Australia by Jim Bowler in 1969. This individual is a well-preserved large male, estimated to be over six feet tall, who was buried with a necklace of approximately 160 pierced Tasmanian Devil teeth. Aside from three initial papers that described the skeleton and its archaeological context, "Nitchie Man" has received little attention. Skeletons dating to the early Holocene in Australia are relatively rare, and few of these are currently available for study. During the warm and wet early Holocene, the western Murray Basin had a series of permanent and ephemeral basin lakes. Shell middens along these lake margins suggest that Australian Aboriginals exploited lacustrine resources in the early Holocene. The Lake Nitchie skeleton itself provides an important opportunity to test hypotheses regarding subsistence behavior in prehistoric Australia. Cross-sectional properties of the humerus, femur, and tibia were calculated from CT images and compared to published samples. Standardized J and J asymmetry for the middistal humeri are both low and most similar to Georgia Coast foragers. Standardized J and  $I_{max}/I_{min}$  at midshaft of the femur and tibia are also low and most comparable to Georgia Coast and Mesolithic foragers. These results suggest a mixed hunting-gathering-fishing subsistence strategy with relatively low mobility and low strains on the upper limb. Male Australian Aboriginals inhabiting the western Murray Basin likely exploited a wide range of niches including ephemeral lakes, rivers, and adjacent Mallee.

*Funding provided by Kansas State University.*

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### **Land of Milk and Honey: Infiltrating Academia to Pursue Overlooked Topics**

KATIE HINDE

School of Human Evolution & Social Change, Arizona State University, Center for Evolution and Medicine, Arizona State University, Brain, Mind, & Behavior Unit, California National Primate Research Center

Situated at the intersection of the social and life sciences, biological anthropology provides exceptional translational opportunities to contribute to improving human health and public policy. The effectiveness of that translation, however, is contingent on the inclusivity of populations that are involved and impacted by the research and the motivation of academics to aid translation through active outreach and growth attitudes. Here I will discuss the development and context of my research studying maternal physiological investment and how this work, anchored in life history theory, is now being applied in medicine and industry to enhance approaches to neonatal health and dairy science. Importantly, my experiences of early life poverty, from rural agricultural to urban artist-activist communities, shaped my professional trajectory and philosophy. Notably, my background influenced my operationalization of the social contract within academia. These perspectives and lived experiences prepared and empowered me to pursue a largely overlooked topic, translate my research broadly, and to direct efforts toward our own academic community by addressing experiences of sexual harassment and assault via the SAFE study. In these ways, professional activism, inward and outward, is an integral component of my research program and scholarly identity. Promoting equal opportunity- whether for breastfeeding medicine or within academic communities- is the manifestation of this professional philosophy.

*Lactation biology research supported by the National Science Foundation (BCS-0921978, BCS-0525025, and IOS-1456174).*

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### **A large-scale analysis of the prevalence of dental caries and calculus over time, from the Bronze Age to the Post-medieval period in Britain**

CARA S. HIRST

Institute of Archaeology, UCL

Dental pathology has long been used as a proxy for diet and masticatory behaviour and a large number of studies have analysed dental pathology in order to inform how diet has varied between cultures, regions or over time. While there are several meta-analysis studies, which have investigated changes in the prevalence of dental pathology, variations in the methods employed by dental pathology studies limit their efficacy. There is therefore a lack of large-scale studies evaluating changes in the prevalence of dental pathology using consistent methods.

This paper evaluates longitudinal changes in the prevalence of dental pathology among British archaeological assemblages.

It is hypothesised that the results from this study will show that diet has changed over time and between sex estimation groups in Britain and that changes in dental pathology will correlate with socio-cultural and technological developments influencing diet and masticatory behaviour.

The dentition of over 1000 human mandible dated to the Bronze Age to Post-medieval periods were analysed and the location and type of dental caries and calculus were assessed. In general the results support the hypothesis, with the prevalence of caries and calculus increasing over time, however, when considering prevalence among each dental category a more complex pattern is apparent.

The results from this study provide a comprehensive assessment of dental changes in Britain, providing both a 'big picture' view as well as detailed assessment of how the prevalence of caries and calculus - and through inference diet - has changed over time.

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### **An assessment of variation and its causes in the face of *Paranthropus***

NOMAWETHU MS. HLAZO<sup>1,2</sup>, TERRY RITZMAN DR. RITZMAN<sup>1,2,3,4</sup> and REBECCA R. DR. ACKERMANN<sup>1,2</sup>

<sup>1</sup>Department of Archaeology, University of Cape Town, <sup>2</sup>Human Evolution Research Institute, University of Cape Town, <sup>3</sup>Department of Neuroscience, Washington University, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University

Although there is general agreement *Paranthropus* species are closely related, recent research suggests that the functional package (comparable adaptations to tough/hard diets) once considered to unite these taxa may have arisen through different means, implying that there may be more ecological diversity within this genus than previously appreciated. This study examines craniofacial variation across 23 *Paranthropus* adult crania (*P. aethiopicus*, *P. boisei* and *P. robustus*) in the context of extant models of variation. Mahalanobis' generalized distance statistic is used to calculate distances between fossils; principal coordinate analyses are used to visualize the distances. We also test whether aspects of morphology are indeed adaptive by applying proportionality tests based on quantitative evolutionary theory against a null hypothesis of genetic drift. Modern humans and African great apes serve as analogues for fossil variation/covariation (V/CV). Results show that there are significant differences between east and South African taxa and a considerable amount of variation within all taxa. Extant V/CV model choice also influences the findings, resulting in different interpretations of *Paranthropus* variation. These

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results indicate that the extent of variation within and across the genus *Paranthropus* is large and varies across taxa, individuals, and cranial regions, suggesting that variation in the face of *Paranthropus* may be too great to be accommodated by current models of within-taxon variation, either due to different patterns/degrees of variation in *Paranthropus* (e.g., sexual dimorphism) or to the presence of previously unrecognized taxa. Proportionality tests suggest that natural selection played a key role in shaping these differences.

*This research was funded by the National Research Foundation of South Africa, the Palaeontological Scientific Trust and the DST/NRF Centre of Excellence in Palaeosciences (COE-Pal).*

### Plio-Pleistocene hominid diversity interpreted through the genetic mechanisms that pattern the dentition

MARIANNE F. BRASIL<sup>1,2</sup>, TESLA A. MONSON<sup>2</sup>, CHRISTOPHER A. SCHMITT<sup>3</sup> and LESLEA J. HLUSKO<sup>1,2</sup>

<sup>1</sup>Human Evolution Research Center, University of California Berkeley, <sup>2</sup>Integrative Biology, University of California Berkeley, <sup>3</sup>Anthropology, Boston University

How we delineate and organize taxa in the hominid fossil record has clear implications for how we quantify diversity. One approach, following the original evolutionary systematic definition of the genus, is to define taxa and interpret diversity in terms of adaptive strategy. Teeth are important in an organism's adaptation to the environment, and so their morphology is likely to reflect adaptive strategy. Here, we apply two recently identified dental phenotypes that capture the output of genetic patterning mechanisms influencing dental proportions within the post-canine dentition. The molar module component (MMC) captures proportional relationships within the molar submodule, whereas the premolar/molar module (PMM) captures the relative dental proportions across the premolar and molar submodules. We examined these phenotypes across hominoids, including extant (n=187) and fossil (n=30) apes, modern humans (n=38), and fossil hominids (n=120), here taking hominid to include all taxa on the human side of the chimp/human split. We find that across hominoids and within the hominids, these two phenotypes differentiate genera remarkably well. Our results suggest that *Homo naledi* and early *Homo* specimens have MMC and PMM values that align with *Australopithecus*, and as such, can be interpreted to have had an *Australopithecus* adaptive strategy for the postcanine dentition. Overall, our research approach suggests that the genus is a more adaptively meaningful taxonomic unit compared to the species level, and therefore, is an arguably more biologically relevant way to conceptualize hominid diversity.

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### Wild chimpanzees consume alcohol using tools

KIMBERLEY J. HOCKINGS<sup>1,2</sup> and TETSURO MATSUZAWA<sup>3</sup>

<sup>1</sup>Anthropology, Centre for Research in Anthropology (CRIA-FCSH/UNL), Portugal, <sup>2</sup>Anthropology Centre for Conservation, Environment and Development, Oxford Brookes University, UK, <sup>3</sup>Primate Research Institute, Kyoto University, Japan

African apes and humans share a genetic mutation that enables them to effectively metabolise ethanol. However, aside from enforced ingestion in captive experiments or anecdotal observations in wild apes, the habitual and voluntary consumption of ethanol in this evolutionary radiation has been documented until now only in humans. Here, we report evidence of the long-term and recurrent ingestion of ethanol from the raffia palm (*Raphia hookeri*, Arecaceae) by wild chimpanzees (*Pan troglodytes verus*) at Bossou in Guinea, West Africa. Local people tap raffia palms and the sap collects in plastic containers. Chimpanzees ingest this alcoholic beverage despite an average presence of ethanol of 3.1% ABV and up to 6.9% ABV. Chimpanzees at Bossou have applied their knowledge of how to make and use elementary technology - a leafy tool - to obtain this new liquid resource. Over 17 years, we observed 51 fermented palm sap drinking events recorded during 20 drinking sessions involving 13 adult and immature individuals. Adult drinking events ranged from 50 - 1920 sec (mean: 636 sec  $\pm$  103, N=28 events, 6 individuals), with individuals averaging 1.0  $\pm$  0.2 l of fermented palm sap per drinking event (range=0.1 - 3.0 l). We also present examples of consumption of fermenting wild fruits by other wild chimpanzee communities, further demonstrating that ethanol does not act as a deterrent to feeding in wild apes. This provides important support for molecular data that the last common ancestor of living African apes and modern humans were not adverse to ingesting foods containing ethanol.

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### Age- and Testosterone-dependent Changes in Facial Asymmetry among Adolescent Bolivian Males and Females

CAROLYN R. HODGES-SIMEON<sup>1</sup>, KATHERINE N. HANSON SOBRASKE<sup>2</sup>, KYLIE STEINHILBER<sup>1</sup>, MICHAEL GURVEN<sup>2</sup> and STEVEN JC. GAULIN<sup>2</sup>

<sup>1</sup>Anthropology, Boston University, <sup>2</sup>Anthropology, University of California Santa Barbara

Facial symmetry may provide reliable information about fitness-relevant characteristics, including genetic quality and immunocompetence. Pathogen exposure and other developmental insults are thought to increase facial fluctuating asymmetry (FA—deviations from bilateral

symmetry) during development. Currently, few studies have investigated the developmental trajectory of facial fluctuating asymmetry. The aim of the present research is to describe age- and hormone-dependent changes in soft-tissue FA among juveniles and adolescents—a period of rapidly accelerating growth in height and other secondary sexual characteristics. We suggest that FA may increase with age in parallel to changes in growth velocity, as there are greater opportunities to accumulate deviations with more rapid growth. To do this, we examined FA in 173 Bolivian Tsimane males and females aged 8 to 23. Salivary testosterone was measured in males only. Results did not support the primary prediction; symmetry was not associated with age, changes in growth velocity, nor testosterone. If FA increases with developmental instability, then it likely occurs before early adolescence.

### New Problems with an Old Idea: Is Human Genetic Variation really Clinally Distributed?

JASON A. HODGSON

Life Sciences, Imperial College London

There is a long tradition in biological anthropology of considering human genetic variation to be clinal, and this has become the textbook explanation taught to anthropology students. But to what extent is it true that "there are only clines", and if it is not true, has it ever been?

In this paper I use publicly available genomic data and a critical review of the population genomics literature to test for clinal versus clustered genetic variation in populations from around the world. Using genetic and geographic distances, I show that genetic variation is often not clinally distributed and that sharp divisions in genetic variation are common throughout the world. In addition, the degree of clustering may be underappreciated due to the intentionally biased sampling of geneticists. Many of these genetic divisions result from large- or small-scale migrations followed by intense culturally mediated assortative mating. Also, many of these divisions have been maintained over tens to hundreds of generations, despite the co-residence of population groups. These findings suggest that human genetic variation is often not clinal and call into question whether clinal variation was ever a widespread and general phenomenon. Understanding the population processes that have driven genetic structuring including migration, population replacement, and assortative mating are crucial to understanding past and ongoing patterns of human evolution.

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### **Stressful Starts: Investigating the impact of 'stressors' on fetal, perinatal and infant health and growth through time**

CLAIRE M. HODSON and REBECCA L. GOWLAND  
Department of Archaeology, Durham University

'Stressors', be they physical, mental or social, have been shown to affect health, growth and development of fetal, perinatal and infant individuals. The DOHaD Hypothesis (Developmental Origins of Health and Disease) highlights the long-term impact that a detrimental *in utero* environment can have on growth and health outcomes. Exposure to early-life stressors can be identified skeletally through both pathological markers and disruption to growth.

Dental development, long-bone lengths and pathological lesions were recorded for 498 fetal, perinatal and infant individuals from the Iron Age through to the 20<sup>th</sup> century. Taking this novel multi-period and multi-population approach, this research observed patterns of growth disruption and pathological lesions over time.

Similarities between populations were identified for both growth disruption and pathological lesions. Inter-site comparisons revealed similarities in prevalence, location and aetiology of pathological lesions, with the frontal bone having the highest prevalence rate of lesions suggestive of intra-cranial haemorrhaging and chronic bleeding. Growth disruption was identified in all of the assessed populations with the femora and tibiae being the most typically affected. A positive correlation between those with growth disruption and pathological lesions has also been identified. This indicates a consistency and longevity in the biological responses to stress identified in these young individuals.

Thus, this new approach to identifying growth disruption whilst considering pathological data demonstrates the relationship between health and growth in past and present populations. This provides a detailed commentary on fetal, perinatal and infant health status over time, furthering our understanding of early development 'stress factors'.

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### **Site dissection as a tool for microscale inferences of health and dietary transitions**

ALIYA R. HOFF and CHRISTOPHER M. STOJANOWSKI

School of Human Evolution and Social Change, Arizona State University

The effects of European colonialism on indigenous population health have been studied in numerous contexts using bioarchaeological methods. Much of this work uses site level inferences based on frequencies of pathological and

non-specific stress indicators to reconstruct changing lifestyles across space and time within a biocultural framework. Here we focus on site level research and incorporate architectural information and cemetery structure to define micro-scale sample subsets that relate to very short periods of time (burial events, < 1 decade) or very specific subsets of the living populations (such as kin groups). We focus on two mission churches from Spanish Florida: San Martin de Timucua and San Pedro y San Pablo de Patale. At San Martin, architectural data combined with published enamel microwear data identifies a distinct dietary transition during the late 16<sup>th</sup> century prior to the formal establishment of a mission at this site. At Patale, biodistance and cemetery structure data define likely kin groups within the church cemetery. Data on kinship are combined with published observations of LEH, cranial pathology, and long bone pathology to document differential mortality and morbidity among the inferred kin groups. That kin groups with higher mortality also demonstrate increased levels of early childhood stress suggests that heterogeneous frailty was evident within the Patale community. The approach demonstrated here provides novel information on health transitions in the past that is complementary to site-based analyses. Furthermore, we demonstrate an approach for identifying heterogeneous frailty within archaeological samples that speaks directly to the osteological paradox.

### **Age-progression and age-regression face modelling in Czech girls from 6 to 15 years based on three-dimensional longitudinal data**

EVA HOFFMANNOVA<sup>1</sup>, JANA KOUDELOVÁ<sup>1</sup>, JÁN DUPEJ<sup>2</sup> and JANA VELEMÍNSKÁ<sup>1</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Charles University, Faculty of Science, <sup>2</sup>Department of Software and Computer Science, Charles University, Faculty of Mathematics and Physics

This study results from actual necessities of forensic practice, especially in accuracy of identification of missing children and adolescents based on facial morphology. Age-related changes in missing children complicate the identification, therefore it is essential to study them to refine the age progression/regression methods.

The study is based on longitudinal research of 282 three-dimensional facial scans of Czech girls (27 girls scanned from 6 to 12 years of age and 22 girls scanned from 12 to 15 years). The longitudinal data help us describe the real growth changes.

Using modern geometric morphometric methods we simulated the age-progression and age-regression modelling of facial scans during childhood and adolescence. Age-progression and age-regression modelling indicated that the

higher error between the modelled faces and real faces was situated in the marginal parts of the face, which were of less importance, for the reconstruction and recognition of individuals. The parts of the face which are of higher importance like eyes, nose, mouth and chin deviated only around 1mm. The results show that the age-progression/regression model helps improving the modelling methods and also helps reducing the subjectivity of age progression/regression methods.

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### **Initial *in situ* bone decomposition after short inhumation times: New insights from experimental degradation assays**

NADJA HOKE, ANDREAS ROTT and MICHAELA HARBECK

Anthropology, Bavarian State Collection for Anthropology and Palaeoanatomy (SAPM)

It is well acknowledged that the initial stages of decomposition within the first few years after death are crucial for the long-term preservation of bone and the integrity of its components. While the decay process of soft tissues has been studied in great detail, analyses of early post-mortem bone tissue reactions are rather scarce.

In order to shed light on degradational mechanisms and their effect on the organic and inorganic bone components, fresh human femur samples from tissue donors were experimentally degraded under a hydrolytic and microbial setup which used two aerobic and two anaerobic bacterial strains.

The observed micro-/nanostructural, biomolecular and isotopic alterations were compared to results obtained from the investigation of 50 long bone samples from a modern cemetery, with inhumation times ranging from 8 to 60 years.

The findings suggest that the acidic byproducts of soft tissue decomposition increase the vulnerability especially of the organic bone components, which are then prone to damage under unfavorable environmental conditions or even analytical protocols. However, a secondary structural restabilization of the tissue seems to occur after the completion of soft tissue decay.

The age at death and thus the degree of mature collagen cross-links could play a major role in the resistance of the tissue in the critical phase of early diagenesis.

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## Addressing the Inertness of Bones and Teeth in Isotopic Studies of Stress and Disease: A review of Advances and Future Prospects

SAMMANATHA HOLDER<sup>1</sup>, LAURIE J. REITSEMA<sup>1</sup>, CAREY J. GARLAND<sup>1</sup>, APRIL K. SMITH<sup>1</sup>, JANAE LUNSFORD<sup>1</sup>, MAGDALENA KRAJEWSKA<sup>2</sup> and TOMASZ KOZLOWSKI<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Georgia,

<sup>2</sup>Institute of Anthropology, Nicolaus Copernicus University

Isotopic studies of stress and disease in past populations are possible because disease states affect the uptake, fractionation, and excretion of stable isotopes in the body. A major limitation of isotopic approaches to bioarchaeological studies of stress is the relatively inert nature of bones and teeth. Bone collagen represents time periods averaging upwards of 30 years and tooth enamel and primary dentine only represent periods in childhood and early adulthood. This synthesis reviews progress and future prospects of dealing with the issue of bone's inertness when studying disease states using isotopic evidence from mineralized tissues. Life history approaches, the bone density fractionation method, and incremental sampling of teeth hold particular promise for lending greater temporal resolution to the skeletal record in isotopic studies of stress and disease. In addition to reviewing the literature, we describe the application of these different approaches in a study of medieval Polish subadults, comparing bulk collagen stable carbon and nitrogen isotope ratios, ratios of collagen sub-fractions of differing density reflecting different temporal snapshots, and ratios of incrementally sampled dentinal collagen in comparison to Wilson Bands (internal enamel defects associated with stress). Our results indicate that further time resolution is possible in stable isotope studies of stress and disease through innovative sampling strategies, which opens new avenues for a biocultural approach in bioarchaeology.

## Growth and opportunities in graduate education: A student's perspective

BRITTANY M. HOLLISTER

Vanderbilt Genetics Institute, Vanderbilt University

Due to its diversity, bioanthropology is at the forefront of many of the most interesting and exciting scientific questions, and the variety of skills and fields that bioanthropology students master create some of the most talented young researchers. The ability to think about the implications of research across many fields leads students to more completely address scientific questions, rather than provide a one-sided viewpoint. These skills also allow scientists to address the most challenging and exciting questions. However, even with these strengths in the training of students, there is still room for growth. Two areas in which we can continue to grow are the

education of students in the perpetually changing discussion of ethical practices and in computational methods of research. With science advancing at a rapid pace, especially in fields such as genetics, it is vital that students are part of the discussions of ethics and that they are trained to think about the most ethical approaches to research questions. Additionally, students need to be trained in computational methods due to their relevance in every field of science. A lack of training has the potential to limit students in their future research. With these strengths and areas of growth in mind, bioanthropology can continue to train incredibly talented scientists.

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## Title: *Homo naledi* posterior endocasts and their significance for understanding brain reorganization

RALPH L. HOLLOWAY<sup>1</sup>, SHAWN HURST<sup>2</sup>, HEATHER M. GARVIN<sup>3</sup>, TOM SCHOENEMANN<sup>4</sup>, WILL B. VANTI<sup>5</sup>, JOHN HAWKS<sup>6</sup> and LEE BERGER<sup>7</sup>

<sup>1</sup>Anthropology, Columbia University, <sup>2</sup>Anthropology, Indiana University, <sup>3</sup>Anthropology, Mercyhurst University, <sup>4</sup>Anthropology, Indiana University, <sup>5</sup>Science and Engineering Library, Columbia University, <sup>6</sup>Anthropology, University of Wisconsin-Madison, <sup>7</sup>Evolutionary Studies Institute, University of Witwatersrand

**Abstract text:** Of the more than 1550 *Homo naledi* fossil fragments discovered in the Dinaledi chamber of the Rising Star cave system, South Africa, seven fragments yield unusually well preserved endocranial morphology that permits identification of likely gyral and sulcal details. Here we describe and interpret the positive relief posterior endocranial features of these fragments as they relate to both the functional and taxonomic aspects of *H. naledi*. Endocranial descriptions are based on physical models as well as digital models and their curvature maps. These models were compared to early hominid endocranial casts, as well as human and chimpanzee endocranial casts, brain casts, and formalin fixed brains. Measurements and morphological features of these endocrania suggest that *Homo naledi* retained a lunate sulcus that was considerably smaller in extent than in chimpanzees, and that the dorsal remnant of the lunate was significantly reduced comparatively. The degree of occipital lobe asymmetry was pronounced on the left side of the preserved fragments, which in modern *Homo sapiens* is suggestive of right-handedness. Thus, while *H. naledi* had a small brain and some primitive retention of the pongid pattern of a lateral and anteriorly placed lunate sulcus, it nevertheless shows suggestions of the derived pattern of occipital lobe neural organization seen in modern *Homo*.

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## Disentangling Fecundability and Fetal Loss: Implications for Age-specific Fertility

DARRYL J. HOLMAN

Anthropology, University of Washington

Wood and his colleagues made numerous contributions to the understanding of completed fertility and fertility variation among natural fertility populations. Much of this work focused on disentangling and estimating levels of pregnancy loss and fecundability. Measurement of total fecundability proved elusive to scholars because an unknown fraction of pregnancies terminate before a pregnancy can be detected. For the same reason, the total probability of pregnancy loss couldn't be measured directly. Wood developed a model that, with plausible biological assumptions, could indirectly estimate total pregnancy loss. This work was extended by one of his former graduate students to a new method using the total pregnancy loss model as the basis to estimate total fecundability. Estimation used observations of menstrual cycles along with sensitive assay-based detection of early pregnancies. Data were collected in a 9-month prospective study of about 500 women in rural Bangladesh. Twice-weekly urine specimens were assayed by a sensitive human chorionic gonadotropin assay.

The results suggest that the probability of pregnancy loss is high (~50%) at age 18 and monotonically increases to >95% by age 48. Total fecundability was high and remained high for most of the reproductive span, contradicting the prevailing idea that female fecundability declines with age. Rather, an increased frequency of early pregnancy loss appears to be the primary driver for the age-specific decline of apparent fecundability, and is likely and important determinant of the cessation of fertility prior to menopause that is observed in natural fertility populations.

## Morphological Integration and Function in the Platyrrhine Mandible

MEGAN A. HOLMES

Physician Assistant Program, Duke School of Medicine

Functional integration within bone is thought to occur due to a coordinated response from shared mechanical stress. Experimental models demonstrated increased masticatory loads are correlated with increased integration. Capuchin monkeys provide an excellent natural experiment to test whether dietary demands influence mandibular integration. Tufted capuchins (*Sapajus* spp.) orally process mechanically resistant foods while non-tufted capuchins

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(*Cebus* spp.) rely primarily on less challenging foods. This analysis tested the prediction that magnitude of integration is greater in tufted capuchin mandibles than non-tufted capuchins due to their demanding diet.

Three-dimensional landmark data were collected from the mandibles of tufted, *S. apella* (n=30) and *S. nigritus* (n=25) and non-tufted, *C. olivaceus* (n=25) and *C. albifrons* (n=25), capuchins. Procrustes superimposition was applied to coordinate data to produce shape variables. Pair-wise comparisons of integration magnitudes were conducted between and within dietary groups using singular value decomposition scores. All significance values are based on permutation tests and Bonferroni corrected ( $\alpha=0.0125$ ).

*S. apella* was the only tufted capuchin to possess significantly greater integration in the mandible ( $p<0.001$ ). Non-tufted capuchins shared a similar degree of mandibular integration with *S. nigritus* ( $p>0.01$ ). Of the capuchins, *S. apella* subsists on the most mechanically challenging foods. This degree of integration could reflect developmental plasticity to elevated mechanical demands or long-term adaptation to extreme masticatory behaviors. Furthermore, high levels of integration has been suggested to constrain shape variation. This study highlights the need to continue unraveling the complex relationships between function, plasticity and constraint in order to understand mandibular morphological diversity.

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### Foot Muscle Size and Longitudinal Arch Biomechanics in a Minimally Shod, Non-industrial Human Population

NICHOLAS B. HOLOWKA, ELIZABETH F. KOCH, MICHAEL RUIZ, IAN J. WALLACE and DANIEL E. LIEBERMAN

Department of Human Evolutionary Biology, Harvard University

Certain factors common to developed post-industrial societies, such as the use of modern shoes and low daily activity levels, are hypothesized to cause or permit weakness of the intrinsic foot muscles that support the longitudinal arch. This weakness can in turn lead to plantar soft tissue damage, and ultimately result in pathological flatfoot (*pes planus*) and associated gait biomechanics problems. However, few studies have tested the relationship between arch function variables and foot muscle strength, and none have quantified foot muscle strength in minimally shod, non-industrial populations. To address this gap we collected data from large, age-matched samples of males over 40 years of age from two populations: indigenous Tarahumara people from northern Mexico (60±7 yrs.) who wear minimal sandals and practice traditional agricultural lifestyles; and habitually shod people from the northeastern United States who have office jobs (60±12 yrs.). We measured the cross-sectional

areas of their intrinsic foot muscles using ultrasound, took static and dynamic measures of longitudinal arch stiffness, and quantified vertical impact forces at foot strike. Tarahumara individuals had larger body mass-corrected abductor hallucis muscles (T: 0.17±0.02; US: 0.13±0.02), arches with higher measures of static stiffness (T: 2397±1098; US: 1682±654), and less arch deformation during walking (T: 9±2°; US: 7±2°). These results suggest that lifestyle factors common to many post-industrial societies may result in weakened foot muscles, less stiff arches, and impaired lower limb biomechanics.

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### Integration and modularity within the human nasal region

NATHAN E. HOLTON<sup>1</sup>, AMANDA PICHE<sup>2</sup> and TODD R. YOKLEY<sup>3</sup>

<sup>1</sup>Orthodontics, The University of Iowa, <sup>2</sup>College of Dentistry, The University of Iowa, <sup>3</sup>Sociology and Anthropology, Metropolitan State University of Denver

Recent studies have detailed the developmental and morphological relationship between the nasal region and other aspects of the craniofacial skeleton. Nevertheless, we currently lack a detailed understanding of the interrelationships among different components within the nasal region. Generally speaking, the nasal region consists of three developmentally distinct components: the superior nasal cavity, which is chondrocranial in origin; the inferior nasal cavity, primarily consisting of the maxilla; and the external nasal region, which is premaxillary in origin. On the one hand, given these distinct developmental origins, one might expect a high degree of modularity among the different nasal components. On the other hand, the different components of the nasal region are functionally related with regard to respiration and air conditioning. Thus, it is possible that the individual components are strongly integrated. Using k=44 3D coordinate skeletal and soft tissue landmarks from CT scans of n=63 subjects we assessed the pattern and strength of integration between different nasal region components based potential developmental and functional interactions. We compared symmetric and asymmetric variation using two-block partial least squares analysis and examined RV coefficients relative to distributions of randomly permuted landmark blocks. Our results indicate a strong degree of modularity across both developmental and functional-based comparisons of nasal cavity components. While the strength of covariation across different landmark blocks was significant in all comparisons ( $P<0.01$ ), all RV coefficients were low relative to RV coefficients obtained

from random permutations. This suggests that the nasal region consists of multiple relatively independent components.

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### Genomic analyses of *Mycobacterium leprae* strains from naturally infected nonhuman primates

TANVI P. HONAP<sup>1</sup>, LUZ-ANDREA PFISTER<sup>2</sup> and ANNE C. STONE<sup>2</sup>

<sup>1</sup>School of Life Sciences, Arizona State University, Tempe, USA, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, Tempe, USA

Leprosy is caused by the bacterial pathogen *Mycobacterium leprae*. Apart from humans, *M. leprae* infects nine-banded armadillos, which serve as a reservoir for this pathogen and are capable of transmitting *M. leprae* to humans. Occasionally, natural leprosy has been observed in nonhuman primates such as chimpanzees, sooty mangabeys, and cynomolgus macaques. It is not known whether leprosy in nonhuman primates primarily occurs due to incidental infections from humans or if nonhuman primates carry *M. leprae* strains and can also transmit them to other species. The aim of this study was to sequence *M. leprae* strains from three naturally infected nonhuman primates (a chimpanzee from Sierra Leone, a sooty mangabey from Nigeria, and a cynomolgus macaque from the Philippines) to study their genetic relationships to human *M. leprae* strains. All animals were born in the wild and developed signs of leprosy during captivity despite never having any contact with a known source. In-solution whole-genome capture and next-generation sequencing technology were used to sequence these *M. leprae* genomes, resulting in average coverage ranging from 7.7- to 106-fold. Phylogenetic analyses show that the cynomolgus macaque *M. leprae* strain belongs to a human *M. leprae* lineage found in Asia. The chimpanzee and sooty mangabey *M. leprae* strains are closely related to each other and belong to a human *M. leprae* lineage found in West Africa. The close relationship of the two African nonhuman primate *M. leprae* strains suggests that different nonhuman primate species may transmit *M. leprae* among themselves.

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### Influence of body size on sexual dimorphism

HALEY HORBALY

Department of Anthropology, University of Tennessee, Knoxville

Sexual dimorphism in human body size is relatively small, with males being, on average, 15% heavier and 9% taller than females. Previous human sexual dimorphism studies have

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demonstrated secular patterns of increasing dimorphism with increasing stature. Additional research has shown reduced accuracy of forensic sex estimation methods on short-bodied populations, and that body size affects morphological expression of skeletal traits associated with aging. However, the influence of body size on the expression of sexually dimorphic skeletal traits has not yet been addressed. Here, this question is explored by analyzing metric data from 200 modern skeletons of white adult males ( $n = 109$ ) and females ( $n = 91$ ). Fourteen measurements were taken from three sexually dimorphic skeletal regions (the cranium, os coxa, and humerus) and minimally-dimorphic cranial and postcranial elements to act as a control. Bivariate correlations were used to test the association between metric traits and body size parameters (stature, weight, and BMI). Males and females were analyzed separately, and in both datasets, traits from the cranium, os coxa, humerus, and minimally-sexually dimorphic regions exhibited statistically significant relationships ( $p < 0.05$ ;  $r$  ranging from 0.189 to 0.541) with all body size parameters. Only three traits in males and five in females showed no significant correlation with body size. The positive correlations between body size and the majority of sexually dimorphic and minimally-sexually dimorphic traits suggest that body size contributes to dimorphic skeletal differences in humans, and should be taken into account in the study of current and past skeletal remains.

### Behavior of Red Uakaris in a Heterogeneous Landscape in Northeastern Peru

ROSE M. HORES and SUSAN M. FORD  
Anthropology, Southern Illinois University

Red uakaris (*Cacajao calvus ucayali*), classified as "Vulnerable" (IUCN Red List, 2016), remain one of the least studied Neotropical primates. This is largely due to their extremely large home and day ranges in flooded and unflooded forests of the Peruvian Amazon. With daily travel distance easily exceeding 7 km, red uakaris traverse multiple sub-habitat types.

Part of a larger project on primate community ecology within a mosaic landscape, we report data on the behavior of red uakaris as they navigate across varying habitats. The study was conducted at the Tahuayo River Amazon Research Center (TRARC) in northeastern Peru (September 2012-February 2014). We tested the hypothesis that certain behaviors would be affected by environment during travel across a heterogeneous landscape.

Uakari follows provided 43.8 hours of direct contact time. Instantaneous scan sampling data were collected at 10 minute intervals on a range of behaviors occurring across five distinct habitat

types ( $n=263$ ). Principal Components Analysis suggests that certain behaviors are correlated with particular habitats. In particular, the behavioral category of "resting" is correlated with being in unflooded forest (*terra firme*), whereas "clinging infant presence," is correlated with being in flooded forests (particularly, *bajjal*). Additional behavioral parameters are under analysis.

This study not only contributes to the limited data of an elusive primate, but also has conservation implications for taxa with long day ranges. Understanding if and how animals modify behaviors in response to different environments can aid in the design of reserves and ensure species survival and reproduction.

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### Bioarchaeological Analysis of Weapon-related Trauma in an Early Medieval Population from Central Europe

LAUREN HOSEK  
Anthropology, Syracuse University

This study is an investigation of the perimortem weapon-related trauma in the skeletal remains of an early medieval population. The human skeletal remains of 115 individuals were examined from the 9-11<sup>th</sup> century Akropole cemetery at the early medieval site complex of Libice nad Cidlinou in what is now the Czech Republic. While 6.9% of these individuals exhibit antemortem healed fractures, three individuals (2.6%) present with evidence for perimortem weapon-related trauma indicative of interpersonal violence. A young adult male (30-34 years), a middle adult male (40-44 years), and a young adult female (25-29 years) each exhibit both cranial and postcranial sharp force lesions from bladed weapons. Data collection required partial reconstruction to sequence the wounds, followed by illustration, description, and interpretation of the injuries. The location, frequency, and distribution of the injuries are presented in this poster. Special attention is given to the multiple craniofacial traumas suffered by each individual as well as the parry, or defensive, wounds on the lower arm bones of the young adult female in order to better understand the circumstances of these violent encounters. The presence of these indicators of violence corroborates with contemporary historical accounts of warfare and massacres in the area. The perimortem trauma experienced by the young adult female, in particular, sheds light on the broader social context of violence in early medieval Central Europe.

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### Assessment of DNA Methylation Patterns in Nonhuman Primate Skeletal Tissue

GENEVIEVE HOUSMAN<sup>1,2</sup>, ELLEN QUILLEN<sup>3</sup> and ANNE C. STONE<sup>1,2</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Center for Evolution and Medicine, Arizona State University, <sup>3</sup>Department of Genetics, Texas Biomedical Research Institute

Epigenetic mechanisms, such as DNA methylation, regulate gene transcription and play crucial roles in the expression of diverse phenotypes within and between species. Among nonhuman primates, DNA methylation patterns have been identified in several soft tissues and associated with phylogenetic, behavioral, and disease-related phenotypes. This study attempts to expand on such exploratory research by assessing how genome-wide DNA methylation patterns from hard skeletal tissues vary among primate taxa and relate to aspects of bone morphology. Skeletal tissue DNA methylation patterns were assessed in right distal femur trabecular bone from baboons ( $n=28$ ), macaques ( $n=10$ ), vervets ( $n=10$ ), chimpanzees ( $n=4$ ), and marmosets ( $n=6$ ) using Illumina Infinium MethylationEPIC arrays. Femur morphologies included 29 linear measurements and 55 three-dimensional digitized landmarks. The methylation states of quality controlled and filtered probes ( $n=15,947$ ) were averaged within each species, and the global changes in methylation between species were calculated using Euclidean distances and used to construct species trees. As hypothesized, these topologies reflect known phylogenetic relationships between taxa. Similar pairwise comparisons also identified species-specific differentially methylated positions – 148 sites in baboons, 75 in macaques, 152 in vervets, 942 in chimpanzees, and 6650 in marmosets. These sites are associated with genes involved in several morphological developmental processes, including skin, muscle, brain, and bone development. Associations of such differentially methylated regions with femoral morphologies provide further insight into species-specific differences. In summary, these data reveal several molecular differences between nonhuman primate taxa and provide possible clues regarding how diverse epigenomes are related to phenotypic variation.

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### Characterizing blood composition in mothers and newborns: Implications for epigenetic studies

CHU HSIAO<sup>1,2,3</sup>, NICOLE C. RODNEY<sup>1,2</sup>, JACKLYN QUINLAN<sup>1,2</sup> and CONNIE J. MULLIGAN<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>Genetics Institute, University of Florida, <sup>3</sup>College of Medicine, University of Florida

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According to the Developmental Origins of Health and Disease (DOHaD) hypothesis, the pathogenesis of disruptive health in later life has roots in the events of the early life environment. There is a growing interest in the epigenetic mechanisms by which this occurs. Additionally, early life stress has been documented to alter the immune system by changing the expression of genes involved in lymphocyte activation. Since epigenetic studies often use DNA extracted from leukocytes, cell heterogeneity in blood samples becomes an important consideration because developmentally distinct cells are differentially methylated. This consideration is especially relevant in newborns since their blood composition changes rapidly as they transition into a new environment.

In our study we recruited new mothers and their newborns from a sexual violence health unit at HEAL Africa Hospital in the eastern Democratic Republic of Congo (n=28). Ethnographic interviews were conducted to query chronic and acute stressors experienced by mothers. Blood was collected at birth from the mother and at birth and day one from the newborn. Complete blood counts (CBCs) were obtained. Mothers' CBCs differed most drastically from the infants' CBCs at birth and day 1. There was a significant difference in the mean percentages of lymphocytes and neutrophils between moms (15.6%; 75.9% respectively) and the newborn at both birth (37.0%; 55.6%) and day 1 (34.4%; 58.6%). Meanwhile the proportion of red blood cells (hematocrit) declined significantly in newborns from birth to day 1 ( $t = 2.077, p < 0.05$ ). Implications for epigenetic studies in newborns will be discussed.

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### Does the Number of Nuclear Microsatellite Loci affect Genetic Distances?

#### Implications for Bioarchaeological Studies

AMELIA R. HUBBARD

Dept. of Sociology and Anthropology, Wright State University

The present study examines how the number of nuclear microsatellite loci impacts genetic distance estimates. mtDNA has long been used in bioarchaeological contexts, though improved techniques for extracting and analyzing ancient nDNA could prompt change. While best practices for selecting suitable, population-specific loci have been ascertained in modern studies, such principles are not easily applied to archaeological populations. Therefore, knowing how many loci are required, at a minimum, to produce reliable distances can be beneficial in contexts where population-specific reference loci have not been well established.

Microsatellite genotypes from 295 Kenyan individuals were analyzed using common genetic

distance measures (e.g., Delta mu, Nei's D). The initial sample of 47 loci was reduced incrementally using a random numbers generator to determine which loci to remove. Preliminary results suggest number of loci does have an impact on genetic distances. Specifically, reduction in the number of loci led to decreased pairwise genetic distances. When fewer than 15 loci were used, pairwise distances were too small to detect differences between populations. Additionally, the distribution of loci across the genome and allele number at particular loci seem to variably affect genetic distance outcomes. Explanations for such patterns will be further explored in this poster.

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### Mobility patterns among pre-historic shell-mound builder populations from coastal Brazil

MARK HUBBE<sup>1,2</sup>, COLLEEN CHEVERKO<sup>1</sup>, MERCEDES OKUMURA<sup>3</sup> and WALTER A. NEVES<sup>4</sup>

<sup>1</sup>Department of Anthropology, The Ohio State University, <sup>2</sup>Instituto de Arqueología y Antropología, Universidad Católica del Norte, <sup>3</sup>Departamento de Antropologia, Museu Nacional, Universidade Federal do Rio de Janeiro, <sup>4</sup>Instituto de Biociências, Universidade de São Paulo

Discussions about mobility patterns in coastal southeast Brazil during the Holocene have focused on the origins and dispersion of the shellmound-building populations that occupied the coast between approximately 8.0 and 1.2 kyr BP, and how these initial groups interacted with the ceramic culture that replaced them. Previous work suggested that certain geographic areas such as the coast of Paraná or the coast of Rio de Janeiro acted as entrance points for new genetic variation from the interior into the coast, which was then followed by gene flow along the coastline. In this study, we test the hypothesis that some regions show evidence of higher genetic diversity, based on the analysis of craniometric measurements of adult skulls (n=398) from 29 shellmound and ceramic sites from the coast of southeast Brazil. Using Mahalanobis distances between series, we identified ten chrono-geographic groups that show a strong geographic structure between them (Mantel test;  $r = 0.49, p < 0.01$ ). Within these regions, we did not identify any significant correlation between the morphological distances among sites and geographic distances, sample sizes or number of sites in region. The Relethford-Blangero test applied to the dataset suggests that São Paulo and Rio de Janeiro shellmounds have more phenotypic variance than expected, whereas Paraná sites fall within the expected range of variance. These results support arguments that mobility was facilitated within regions, and that higher

morphological diversity was seen in the northernmost sites in the study area, instead of in Paraná, as was expected from previous studies.

### The Global Diversity of the Human Oral Microbiome

ALEXANDER HÜBNER and MARK STONEKING  
Evolutionary Genetics, MPI for Evolutionary Anthropology, Leipzig

Studying genetic variation of human populations allows making inference about their structure and migration patterns and hypothesizing about their population history. Human populations share their history with their microbiomes and the population structure of some bacteria, e.g. the gut pathogen *Helicobacter pylori*, resembles the structure of their human hosts. The human oral microbiome is often sampled alongside the human DNA when saliva is used as DNA source, but little is known about its genetic variation and its population structure.

We investigated the genetic variation of the oral microbiome in all saliva samples from the Simons Genetic Diversity Project, 14 individuals from six populations. We aligned the whole-genome shotgun sequences to a non-redundant gene catalog based on bacterial species that were previously recovered from the oral cavity provided by the Human Oral Microbiome Database. Using between 3.1-16.0 Gb of aligned sequences per individual, we estimated the relative abundance of taxa in each individual and identified 2.31 million single nucleotide polymorphisms in 93,069 bacterial genes.

Preliminary analysis of the global FST per bacterial gene to investigate the population structure indicated that the average value was 9 times higher than in the human host populations. While we did not observe geographic structure based on relative abundances of bacteria, the phylogenetic tree based on the FST values of the bacterial genes closely resembles the tree based on the human genetic sequence data.

Overall, this shows that the oral microbiome holds promise for studying in-depth the co-diversification of the saliva microbiome and the human host.

### Understanding (mis)classification trends of Hispanics in Fordisc 3.1: Incorporating cranial morphology, microgeographic origin, and admixture proportions for interpretation

CRIS E. HUGHES<sup>1</sup>, BEATRIX DUDZIK<sup>2</sup> and BRIDGET FB. ALGEE-HEWITT<sup>3</sup>

<sup>1</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>Anthropology, University of Tennessee at Knoxville, <sup>3</sup>Biology, Stanford

Dudzik and Jantz<sup>1</sup> observed misclassification patterns of Hispanics with Fordisc 3.1, likely

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associated with the population histories of Latin America. Here, we perform a deeper analysis of the misclassification trends, focusing on Mexicans with known regions of origin (Northern, Central, Southern Mexico). Building on established evidence of the geographically structured distribution of European admixture, which exhibits a northerly increase across Mexico<sup>2,3</sup>, we hypothesize that an individual's region of origin correlates with the nature of their misclassification by Fordisc 3.1.

Using discriminant function analysis (DFA) and the world-wide reference samples of Fordisc 3.1, we examined population substructure in modern Mexican and Hispanic cases samples (N=523), largely representing forensic cases from PCOME.<sup>4</sup> Northern and Southern Mexicans appear more strongly associated with world-wide samples with, respectively, elevated (e.g., American Blacks and Whites) and reduced (Guatemalans and Native Americans) amounts of European ancestry. Additionally, Fordisc 3.1 classifications generated for each Mexican case yielded trends consistent with the findings above, in that region of origin appears to be a significant factor in determining the group into which a misclassified individual was assigned ( $\chi^2 = 29.09$ ,  $p = 0.01$ ). Finally, mixture analyses were performed to compare the DFA results with the membership proportions obtained from an unsupervised model-based clustering of the craniometrics, which adopts an admixture approach to structured variation and population inference at a finer-grained, regional scale.<sup>5</sup>

The relationship among cranial morphology, microgeographic origin, and admixture proportions can be used to better understand the evolutionary, population historical and statistical reasons for Fordisc 3.1 results.

### Alms for the Poor? Poverty, stress, and mortality in industrial-era Albany, New York

GAIL M. HUGHES-MOREY

Biology and Health Sciences, The Sage Colleges

Cox proportional hazards analyses were used to examine the associations between skeletal indicators of non-specific stress and mortality in a sample of industrial-era paupers from the Albany County Almshouse (Albany, New York). Cribra orbitalia and porotic hyperostosis, linear enamel hypoplasia, and short femur length relative to the sex-specific mean were considered indicative of childhood stress, while periosteal new bone formation was considered evidence of stress during adulthood. The risk of mortality associated with periosteal new bone formation was compared between those who exhibited evidence of childhood stress and those who did not. There were no significant associations between periosteal new bone formation, or femur length, and mortality. Cribra orbitalia/porotic hyperostosis

was associated with increased risk of mortality in both sexes, and linear enamel hypoplasia was associated with increased risk of mortality in females. There were no significant associations between periosteal new bone formation and mortality, regardless of the presence or absence of cribra orbitalia/porotic hyperostosis or short femora. Periosteal new bone formation was, however, associated with reduced risk of mortality in both males and females with linear enamel hypoplasia. This may suggest reduced frailty among those who survived a particular stressor, or suite of stressors, during childhood. Results are interpreted in the context of the osteological paradox and in light of the social and economic upheavals of the 19<sup>th</sup>- and early 20<sup>th</sup>-centuries.

### Later Stone Age infant remains from the Grotte des Pigeons at Taforalt

LOUISE HUMPHREY<sup>1</sup>, ALI FREYNE<sup>1</sup>, ABDELJALIL BOUZOUGGAR<sup>2</sup> and NICK BARTON<sup>3</sup>

<sup>1</sup>Earth Sciences, Natural History Museum, <sup>2</sup>Institut National des Sciences de l'Archéologie et du Patrimoine, Rabat-Morocco, <sup>3</sup>Institute of Archaeology, University of Oxford

Excavations by Abbé Roche in the 1950s recovered an extensive series of Iberomaurusian (Later Stone Age) burials from Grotte des Pigeons at Taforalt, Morocco. Excavations since 2005 have revealed a further series of inhumations in an alcove at the back of the cave. Twelve complete or partial skeletons were recovered from in situ primary burials, together with disarticulated bones representing at least three additional individuals. Radiocarbon dates on human bone yielded age estimations between 15,077 Cal BP and 13,892 Cal BP. These are the earliest well constrained dates for any directly or indirectly dated Iberomaurusian human remains, post-dating the earliest archaeological evidence for this period by nearly 7000 years.

The newly excavated assemblage included three infants of perinatal age and three older infants. Five of these exhibited skeletal measurements consistent with their state of dental development, but the oldest infant showed evidence for severe growth faltering. The infant burials revealed funerary treatments comparable to those of the adults implying that individuals were not treated differently according to their age at death. Burial features include a seated or semi-reclining body position, occasional use of ochre, placement of bodies beneath large stones, and inclusion of horn cores and other objects; but none of the burials incorporated all of these features. Intensive re-use of deposits and close spatial proximity had caused truncation of some burials and secondary re-deposition of disturbed skeletal elements, but in contrast to the Roche series, there was no unequivocal evidence for deliberate manipulation or removal of skeletal parts.

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### Using a Mouse Model to understand the Relationship between Skeletal and Ectodermal Trait Variation in Mammalian Hybrids

ROBYN A. HUMPHREYS<sup>1,2</sup>, TERRENCE RITZMAN<sup>1,2,3,4</sup>, KERRYN WARREN<sup>1,2</sup>, CHRISTOPHER J. PERCIVAL<sup>5,6,7</sup>, BENEDIKT HALLGRIMSSON<sup>5,6,7</sup> and REBECCA R. ACKERMANN<sup>1,2</sup>

<sup>1</sup>Department of Archaeology, University of Cape Town, <sup>2</sup>Human Evolution Research Institute, University of Cape Town, <sup>3</sup>Department of Neuroscience, Washington University School of Medicine, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University, <sup>5</sup>Institute for Child and Maternal Health, Alberta Children's Hospital, <sup>6</sup>The McCaig Bone and Joint Institute, University of Calgary, <sup>7</sup>Department of Cell Biology and Anatomy, University of Calgary

Hybridization played an important role in human evolution. With significant differences in soft tissue traits between hybridizing groups, understanding how phenotypic variation of these traits is affected by hybridization is important. Ectodermal trait variation is also of interest because primate hybrids show increased atypical non-metric dental and cranial trait variation thought to be the result of interactions between parental genomes which have diverged for ectodermal trait development (e.g. hair development). We use a mouse model to look at the effect of hybridization on coat morphology, specifically coat dorsal ventral color contrast (DVCC) a pattern established early in mouse development. Using standardized photographs the difference in mean RGB values for the dorsal and ventral coat were used to determine variation in DVCC. Previous data showed increased DVCC is a dominant trait with F1 hybrids having an increased DVCC phenotype if one parent has a large DVCC. This pattern continues in F2 and backcrossed hybrids. Hair banding patterns of hybrid hairs from the dorsal and ventral region are also different to that of parental groups indicating a disruption in the establishment of dorsal ventral coat patterning in developing hybrids. Future work will compare DVCC and skeletal data to determine if this disruption in development of dorsal ventral patterning in coat color correlates with hybrid skeletal traits. This is a first step in determining if we can use hybrid skeletal trait data to make informed inferences about soft tissue traits affected by the same developmental processes such as hair and teeth.

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### Investigating intra-skeletal variation in cortical bone strength parameters of the radius and tibia in non-osteoporotic males

RANDEE L. HUNTER<sup>1</sup>, KAREN C. BRILEY<sup>3</sup>, ALLISON J. YARD<sup>1</sup>, MICHELLE M. MURACH<sup>1</sup> and AMANDA M. AGNEW<sup>1,2</sup>

<sup>1</sup>Skeletal Biology Research Laboratory, The Ohio State University, <sup>2</sup>Department of Anthropology, The Ohio State University, <sup>3</sup>Department of Radiology, The Ohio State University

The goal of this study is to investigate intra-skeletal variation in measures of cortical bone strength in the radius and tibia in non-osteoporotic males. The range of variation in bone quality for individuals deemed "skeletally healthy" through traditional methods needs to be explored. Left and right radii and tibiae were excised from 30 male cadavers ranging in age from 33 to 79 years ( $64.13 \pm 11.31$ ) and with DXA lumbar spine T-scores qualifying them as non-osteoporotic ( $> -2.5$ ). Quantitative clinical CT was performed on *ex vivo* elements to calculate volumetric bone mineral density (vBMD) at 30% radius and 38% tibia sites. Total area (Tt.Ar), cortical area (Ct.Ar), section modulus for both the anterior ( $Z_{ant}$ ) and posterior ( $Z_{post}$ ) cortices and robusticity (Tt.Ar/bone length) were quantified. Paired samples t-tests indicate significant differences in Tt.Ar ( $p < 0.01$ ), Ct.Ar ( $p < 0.005$ ), robusticity ( $p < 0.01$ ),  $SSI_{ant}$  ( $p < 0.05$ ) and  $SSI_{post}$  ( $p < 0.01$ ) between left and right elements, as well as significantly higher  $SSI_{post}$  in the tibia and  $SSI_{ant}$  in the radius. However, there were no significant differences in vBMD between right and left sides for the radius ( $p > 0.05$ ) or tibia ( $p > 0.05$ ). Side differences in variables related to bone strength could be the result of functional adaptation due to laterality or side preference. Intraskelletal comparisons indicate significant correlations for  $SSI_{ant}$  ( $r = 0.484$ ;  $p < 0.0001$ ) and  $SSI_{post}$  ( $r = 0.568$ ;  $p < 0.0001$ ). This is a non-destructive method of capturing intra-individual variation in cortical bone strength parameters and suggests differential response to mechanical loading. Considering these differences within individuals has implications for assessing skeletal health within past and present populations.

### The "other" drug: Implementing bird grasshoppers as a treatment for anemia

KAYLA J. HURD

Department of Anthropology, Wayne State University

In a recent publication, the Food and Agriculture Organization of the United Nations (FAO) states that "entomophagy can be promoted for three reasons: health benefits, environmental benefits, and the improvement of our livelihoods involving economic and social factors." Their main argument is that insects are a vast resource for human diets, especially when the population is projected to increase. While the potential of insects as a food source is important, one area

that is perilously overlooked is their medicinal potential. This poster examines the efficiency of bird grasshoppers as a substitute for anemia treatments, as practiced by many rural communities in Mexico. Here the genus *Schistocerca* was examined for Vitamin B6, or more specifically pyridoxine, and iron content, two common supplements used to treat anemia. The recommended dietary allowance (RDA) for iron is from 7-27 mg/day varying with age and sex, and the iron content of *Schistocerca* falls well into that range at 8.38 mg/100g dry weight. While other sources of iron and pyridoxine such as beef, poultry, and even over-the-counter supplements provide sufficient content, these resources are costly. Utilizing bird grasshoppers for medicinal purposes is a low cost aide for developing countries with no access to such supplements. Identifying this, along with other benefits, helps to relinquish the stigma associated with edible insects as well as facilitate more widespread use of this underutilized resource.

### *Homo naledi's* frontal lobe: Modern in form, ancestral in size

SHAWN D. HURST<sup>1,2</sup>, RALPH L. HOLLOWAY<sup>3</sup>, HEATHER M. GARVIN<sup>4</sup>, TOM SCHOENEMANN<sup>1,2</sup>, WILLIAM B. VANTI<sup>5</sup>, JOHN HAWKS<sup>6</sup> and LEE R. BERGER<sup>7</sup>

<sup>1</sup>Department of Anthropology, Indiana University,

<sup>2</sup>The Stone Age Institute, <sup>3</sup>Department of Anthropology, Columbia University, <sup>4</sup>Department of Anthropology/Archaeology and Applied Forensic Sciences, Mercyhurst University, <sup>5</sup>Science and Engineering Library, Columbia University, <sup>6</sup>Department of Anthropology, University of Wisconsin-Madison, <sup>7</sup>Evolutionary Studies Institute and Centre of Excellence in PalaeoSciences, University of the Witwatersrand

There is no greater difference in frontal lobe morphology between apes and *Homo sapiens* than in the inferior frontal gyrus. The degree to which this evolutionary change is due to increase in brain size versus brain reorganization has long been in dispute. Here we show the *Homo naledi* DH3 fossil skull fragment, recently discovered in the Dinaledi chamber of the Rising Star cave system, South Africa, provides an endocast with an unusual degree of detailed cortical morphology that is essential to answering this question. In the ancestral morphology seen in apes and *Australopithecus*, the fronto-orbital sulcus forms the anterior boundary of the orbital cap, whereas the homologous sulcus in modern *Homo* has moved posteriorly and been draped over by the formation of the frontal opercula associated with Broca's language area in humans. Despite an overall brain size similar to those of apes and australopithecines, *H. naledi* exhibits the modern condition of the orbital cap, bound anteriorly by an extended inferior frontal sulcus. In addition, a clear vertical ramus of the lateral fissure and its horizontal branch permits easy identification of

a modern configuration of the frontal opercula. DH3 thus shows a modern *Homo*-like frontal brain organization despite its small size, which separates it from endocasts of *A. africanus*, *A. afarensis*, *A. sediba*, and *H. floresiensis*.

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### The effect of temperature and population history on the shape of the distal and proximal epiphyses of the tibia

PERE IBÁÑEZ-GIMENO<sup>1,2</sup>, THOMAS G. DAVIES<sup>1,3</sup> and JAY T. STOCK<sup>1,4</sup>

<sup>1</sup>PAVE Research Group, Department of Archaeology and Anthropology, University of Cambridge,

<sup>2</sup>McDonald Institute for Archaeological Research, Department of Archaeology and Anthropology, University of Cambridge, <sup>3</sup>School of Earth Sciences, University of Bristol, <sup>4</sup>Downing College, University of Cambridge

Skeletal size and shape are strongly affected by natural selection, with climate one of the most significant factors. Nevertheless, skeletal variation is also influenced by neutral processes, although these remain relatively unexplored for long bone variation. Here, we apply geometric morphometric methods to analyze the effect of temperature and population history on the shape of the proximal and distal epiphyses of the human tibia in hunter-gatherer populations around the globe. Population history is assessed using an isolation by distance model, where geographical distances between pairs of populations are used as proxies for neutral genetic differences. The results show no significant differences for tibial shape between males and females and only minor allometric effects in the distal epiphysis. Significant differences among populations for both the proximal and distal epiphyses were observed. Mantel tests indicate that these differences in the distal epiphysis are probably triggered by adaptation to different temperature regimes, whereas the proximal epiphysis is largely unaffected by these. The results also indicate some neutral effects of population history on the shape of the distal tibia, although this is not as significant an influence as selective pressures. Although further research is warranted to determine the role of lifestyle and activity, this preliminary study suggests that the shape of the proximal and distal epiphyses of the tibia evolved following different processes.

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## Human diet in the early medieval period: Tooth wear, mastication, enamel thickness and its relationship to social stratification

ALEXANDRA IBROVÁ<sup>1</sup>, JÁN DUPEJ<sup>1,2</sup>, PETRA STRÁNSKÁ<sup>3</sup>, PETR VELEMÍNSKÝ<sup>4</sup>, LUMÍR POLÁČEK<sup>5</sup> and JANA VELEMÍNSKÁ<sup>1</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>2</sup>Department of Software and Computer Science Education, Faculty of Mathematics and Physics, Charles University, <sup>3</sup>Institute of Archaeology, Academy of Sciences of the Czech Republic, Prague, <sup>4</sup>Department of Anthropology, National Museum, Czech Republic, <sup>5</sup>Institute of Archaeology, Academy of Sciences of the Czech Republic, Brno

In highly stratified medieval societies, diet is one indicator of individual's socioeconomic status. Diet leaves traces on hard tissues through mastication that causes attrition and directional asymmetry (DA) of facial skeleton. The aim of our study was to validate dietary differences between 2 burial sites of Great Moravia of presumably different socioeconomic status (acropolis, suburbium) through analysis of facial skeleton DA and attrition using methods of 3D geometric morphometrics. We expected the DA and attrition to differ between the sites. Additionally, we recorded enamel thickness of elite and rural graves. We expected the enamel thickness to differ between them, as it selectively responds to changes of subsistence.

The material consisted of acropolitian (N=125), suburbial (N=68), elite (N=37) and rural (N=29) graves. Attrition of premolars and molars was evaluated using scoring systems. 3D coordinates of 35 mandibular landmarks were scanned with MicroScribe G2X and micro-CT scans of upper M2 with isotropic voxel size 17.88 µm with SkyScan 1172.

The acropolis sample had slightly lower attrition score than the suburbium. Mandible DA values did not differ between the areas. However, we found directional changes of mandibular landmarks showing right chewing side preference of the sample.

Lower attrition score of acropolis may support expected higher consumption of meat in higher socioeconomic classes. However, the analysis of acropolis and suburbium did not show any significant dietary differences according to applied masticatory forces. The differences in diet were concluded to be more subtle; therefore, the enamel thickness analysis has been included.

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## Intentional Dental Staining in the Mariana Islands

RONA M. IKEHARA-QUEBRAL<sup>1</sup>, TIMOTHY M. RIETH<sup>1</sup>, ALEX E. MORRISON<sup>1</sup>, MICHAEL

PIETRUSEWSKY<sup>2</sup> and MICHELE TOOMAY DOUGLAS<sup>2</sup>

<sup>1</sup>Honolulu Office, International Archaeological Research Institute, Inc., <sup>2</sup>Department of Anthropology, University of Hawai'i at Mānoa

Intentional modification of human teeth during life, a cultural phenomenon that has been practiced world-wide for several millenia, includes the purposeful alteration of a tooth's shape or color. Some tooth modifications observed in the bioarchaeological record are readily discerned as deliberate (e.g., intricate patterns carved into the enamel surface). Dental enamel staining is more challenging to determine as intentional, since incidental stains can accumulate from food consumption and post-mortem taphonomic processes. Complicating factors include the fading of intentional stains over time and their possible co-occurrence with incidental stains. In the Mariana Islands, ethnohistoric accounts indicate the Chamorro people were deliberately staining their teeth more than one hundred years after Spanish Contact (A.D. 1521), but little is known about earlier periods. In bioarchaeological studies of pre-Contact and early post-Contact samples from Micronesia, it has long been presumed that much of the observed enamel discoloration is solely the result of habitual betel nut chewing. Based on this assumption, researchers often did not consider other causes of staining and consequently did not collect the empirical evidence necessary to evaluate patterns that could indicate staining was deliberate. We recommend a data collection protocol that specifies, per tooth, which enamel surfaces are stained. We also provide a unique new way to report staining attributes. By using these methods, a strong case is presented for intentional dental staining in bioarchaeological samples from the Mariana Islands.

## The complicated genetic landscape of skin color in India

FLORIN MIRCEA ILIESCU<sup>1</sup>, GEORGE CHAPLIN<sup>2</sup>, NIRAJ RAI<sup>3</sup>, GUY JACOBS<sup>1</sup>, CHANDANA BASU MALLICK<sup>4,5</sup>, ANSHUMAN MISHRA<sup>3</sup>, RIE GOTO<sup>1</sup>, RAKESH TAMANG<sup>3</sup>, GYANESHWER CHAUBEY<sup>4</sup>, IRENE GALLEGU ROMERO<sup>6</sup>, FEDERICA CRIVELLARO<sup>7</sup>, RAMASAMY PITCHAPPAN<sup>8</sup>, LALJI SINGH<sup>3</sup>, MARTA MIRAZON-LAHR<sup>7</sup>, MAIT METSPALU<sup>4,5</sup>, KUMARASAMY THANGARAJ<sup>3</sup>, TOOMAS KIVISILD<sup>1,4,5</sup> and NINA G. JABLONSKI<sup>2</sup>

<sup>1</sup>Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Anthropology, The Pennsylvania State University, <sup>3</sup>CSIR-Centre for Cellular and Molecular Biology, Hyderabad, <sup>4</sup>Estonian Biocentre, Tartu, <sup>5</sup>Department of Evolutionary Biology, University of Tartu, <sup>6</sup>School of Biological Sciences, Nanyang Technological University, <sup>7</sup>Leverhulme Centre for Human Evolutionary Studies, University of Cambridge, <sup>8</sup>Chettinad Academy of Research and Education, Chettinad Health City

Human skin color represents a classic example of a quantitative trait that is highly polymorphic in humans. Models based on natural selection suggest that pigmentation variation has accumulated in response to human dispersals and colonization of diverse environments, primarily due to differences in the damaging versus vitamin D synthesis-related effects of UV radiation (UVR) at different latitudes. Indian populations, despite being spread across a relatively narrow latitudinal range, show a high level of variation in skin color phenotype. Using recorded Melanin Index (MI) data from populations throughout the subcontinent we previously suggested the presence of phenotypic "overprinting" due to successive population migrations and the action of both natural and sexual selection forces. We now show that, in the context of pronounced endogamy, the role of the SLC24A5 functional polymorphism on skin color variation in India is variable on a population dependent basis. The presence of epistasis between skin color genes in studied populations leads to some individuals homozygous for the SLC24A5 European allele having highly melanized skin; hence, the skin lightening effect of the rs1426654-A allele is overridden by the action of novel variants within skin color genes. Finally, considering the migration patterns and the variable social selection forces at play across India, we tested the correlation between the skin color dimorphism observed within some Indian populations and genetic variation patterns. These results thus further illustrate the complex genetic landscape of skin color around the world and warrant caution when predicting color phenotypes from ancient DNA studies.

## Hutchinson's dental criteria diagnose congenital syphilis in pre-Columbian Old World

STELLA IOANNOU, RENATA J. HENNEBERG and MACIEJ HENNEBERG

Biological Anthropology and Comparative Anatomy Research Unit, University of Adelaide

The origin of syphilis is a much-debated topic. The prevailing opinion is that Columbus's crews brought the disease to Europe in 1493. There is also a lack of written documentation of the disease's presence in the Old World prior to 1493. There is some palaeopathological pre 15th century skeletal evidence (Costebelle, Hyères, France; Norwich, England; Castle Mound cemetery, Huntington, England; Rivenhall, Essex, and Ipswich, Suffolk, England; and Apple Down Anglo-Saxon cemetery, West Sussex, England) but signs of probable syphilis in those individuals are considered controversial. Congenital syphilis produces perinatally specific dental signs that are pathognomonic. Nineteenth century physicians described those changes in detail together with additional dental changes in patients treated with mercury for congenital syphilis. These, besides

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“screwdriver” upper central incisors and “mulberry” molars include other hypoplastic incisors, pitting hypoplasia on canines and a range of variation in first molar occlusal morphology. Hitherto, the full range of congenital-syphilis-related changes was not used for paleopathological diagnoses. Here a full range of clinical observations of specific dental abnormalities in congenital syphilis patients described by Hutchinson, Moon and Fournier in the 19th century is used to assess dentition of remains predating 1493 from Nicaea, Turkey, St. Pölten, Austria, and Metaponto, Italy. Similarity of dental signs in these early individuals to clinical cases diagnoses pre-Columbian presence of the disease in the Old World. It is less clear that putative New World pre-Columbian congenital syphilis cases (Yugtuë, Oaxaca, Mexico and Gabriola Island, British Columbia) have dental changes that fit the 19th century clinical range.

### Preservation poor—data rich: bioarchaeology of the Neolithic peoples from Gebel Ramlah, Western Desert, Egypt

JOEL D. IRISH<sup>1</sup>, AGNIESZKA CZEKAJ-ZASTAWNY<sup>2</sup> and JACEK KABACIŃSKI<sup>3</sup>

<sup>1</sup>Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, Liverpool, United Kingdom, <sup>2</sup>Institute of Archaeology and Ethnology, Polish Academy of Sciences, Kraków, Poland, <sup>3</sup>Institute of Archaeology and Ethnology, Polish Academy of Sciences, Poznań, Poland

Gebel Ramlah sits 150 km west of Abu Simbel in extreme southern Egypt. During much of the Holocene, a seasonal lake was present on the mountain's south side that attracted scores of Neolithic peoples. Many habitation sites are evident, but it is the numerous Final Neolithic cemeteries that exemplify this area. To date, our team has investigated >200 burials and their biocultural remains. Given the remote desert location none have been looted, but preservation is poor; skeletal remains not exposed by deflation—and literally sand-blasted to bits—are extremely friable. Nevertheless, bioarchaeological analyses of remains *in situ* and in field labs have provided information on individual and group adaptation, interaction, and mobility during a critical prehistoric period.

In brief, these semi-nomadic, intensive collectors/herders split time between the desert and Nile Valley. They apparently enjoyed exceptional skeletal health, including a lack of caries. Tall stature also suggests wellbeing, if not relatedness to more southerly peoples. Dental and craniometric affinities support the latter possibility. Grave goods, some obtained via long-distance trade, are distributed equivalently among individuals irrespective of sex or age—including children. And a range of cemeteries has been found, varying in grave orientation, body position, and grave goods. Recently, one was found that contains

41 infants, including perinates buried with three adult females. Not only is it ostensibly the earliest cemetery designated for infants, but the oldest in the Western Desert (mid-5<sup>th</sup> millennium BCE). A wide-ranging overview of these and other findings from this ongoing project is presented.

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### Bonobos Exhibit Higher Connectivity in the Ventral Anterior Cingulate Cortex Relative to Chimpanzees

HABON A. ISSA<sup>1</sup>, NICKY STAES<sup>1</sup>, JARED P. TAGLIALATELA<sup>2</sup>, CHERYL D. STIMPSON<sup>1</sup>, WILLIAM D. HOPKINS<sup>3</sup> and CHET C. SHERWOOD<sup>1</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, George Washington University, <sup>2</sup>Department of Ecology, Evolution, and Organismal Biology, Kennesaw State University, <sup>3</sup>Neuroscience Institute and Language Research Center, Georgia State University

Despite being closely related, bonobos and chimpanzees exhibit some remarkable behavioral differences. It has been reported that chimpanzees tend to be more aggressive, territorial, and risk-taking, while bonobos exhibit greater social tolerance, higher rates of socio-sexual interactions, and risk-averseness. To elucidate the potential neuroanatomical changes that might accompany these differences, we examined the cytoarchitecture of selected brain areas implicated in these behaviors. In bonobos and chimpanzees, we compared neuropil fraction of the anterior cingulate cortex (ACC), a region associated with cognitive and emotional processing, and the nucleus accumbens (NAc), which is associated with risk/reward decision-making and control. The putamen was included as a control region. The neuropil fraction quantifies unstained space surrounding cell bodies in histological sections and therefore serves as a proxy for the amount of connectivity in a given region. Bonobos had overall higher neuropil fractions in the ACC compared to chimpanzees, but the effect was only significant in layers V-VI of the ventral part of the ACC ( $F(1,8)=5.63, p=0.005$ ). No significant inter-species differences were found in the NAc ( $t(10)=0.38, p=0.709$ ) or the putamen ( $t(10)=-0.34, p=0.709$ ). As the ACC is anatomically divided into a dorsal “cognitive” and ventral “affective” area, the higher connectivity in the ventral ACC in bonobos may be associated with species differences in socio-emotional behaviors or temperaments. Further research will examine if variation in the number of Von Economo neurons of the ACC may provide additional insight into the neural basis of behavioral differences between bonobos and chimpanzees.

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### Zygomaxillary morphology of *Macaca cf. robusta* (Middle Pleistocene, South Korea) and its phylogenetic and evolutionary implications

TSUYOSHI ITO<sup>1,2</sup>, YUNG-JO LEE<sup>3</sup>, TAKESHI D. NISHIMURA<sup>1</sup> and MASANARU TAKAI<sup>1</sup>

<sup>1</sup>Department of Evolution and Phylogeny, Primate Research Institute, Kyoto University, <sup>2</sup>The Keihanshin Consortium for Fostering the Next Generation of Global Leaders in Research (K-CONNEX), Kyoto University, <sup>3</sup>Institute of the Korean Prehistory

Little is known about the biogeographical and evolutionary history of macaques in East Asia, because the phylogenetic positions of fossils are still unclear. Here, we examined the zygomaxillary remain of *Macaca cf. robusta* (Middle Pleistocene, South Korea) to infer its phylogenetic relationship to living species. We took 195 fixed- and semi-landmarks on the zygomaxilla of the fossil specimen and the 131 specimens from 13 living species. After sliding semi-landmarks and Generalized Procrustes analysis, we applied multivariate statistics to evaluate the phenetic affinities of the fossil to the living species. In addition, we reconstructed the most parsimonious phylogenetic hypothesis by adding the fossil to a branch of the molecular phylogenetic tree of living taxa. The fossil was the most similar to but on the margin of the variation of living Japanese macaques (*M. fuscata*) in the zygomaxillary morphological space. The second closest was the continental relatives, namely living rhesus macaques (*M. mulatta*). Parsimonious reconstruction showed that the fossil was the most closely related to the Japanese macaques. These results remained even after controlling the effects of allometry. These findings suggest that the ancestral lineage of Japanese macaques or its close relative was distributed in the Middle Pleistocene of Korean Peninsula, where no living species of macaques inhabits at present. Some morphological characteristics of Japanese macaques could have been formed before they dispersed from the continent to Japan archipelago.

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### Long bone growth in a mid-19<sup>th</sup> century documented sample of the urban poor from Bethnal Green, London, UK

RACHEL IVES<sup>1,2</sup> and LOUISE T. HUMPHREY<sup>1</sup>

<sup>1</sup>Earth Sciences, Natural History Museum, London, <sup>2</sup>AOC Archaeology Group, Twickenham

Research on differences in male and female long bone growth during childhood in past populations

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is limited and usually constrained by the lack of personal identification. A series of documented burials dating between 1840 and 1855 A.D. from Bethnal Green, London, UK were studied. The series is broadly associated with the urban poor and families of low socio-economic status occupations.

Maximum long bone diaphyseal lengths were measured for 78 male and 78 female children with a documented age at death between birth and 12 years. Comparisons were made with modern reference data from North America. For each long bone, differences in bone length between the measured and expected value were expressed as standard deviations from the modern mean value. An average standard deviation value for all available long bones (ASDV) was calculated for each juvenile, with negative values reflecting juveniles smaller than the modern standard.

Males and females exhibited similar patterns of growth. All long bones exhibited severe growth deficits relative to the modern reference series. Twenty nine percent of infants aged under 6 months had an ASDV below minus two compared to 86% of children aged 6 months to one year, and 94% of children aged 1 to 12 years.

Growth faltering in both males and females was established during infancy (<1 year) with no evidence for recovery in older age groups. By the mid-19<sup>th</sup> century, Bethnal Green was notorious for its impoverished living conditions, limited sanitary provision and poor nutritional quality, contributing to growth stunting.

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### Cranial growth in six- to eight-year-old humans: comparison of standard metric and 3D coordinate data

DANA E. BECKER<sup>1</sup>, NATASHA A. CASTELLON-HINKLE<sup>1</sup>, LAURA E. CIRILLO<sup>2</sup>, REBECCA S. JABBOUR<sup>3</sup> and GARY D. RICHARDS<sup>4</sup>

<sup>1</sup>Integrative Biology, University of California, Berkeley, <sup>2</sup>Anthropology, California State University, Chico, <sup>3</sup>Biology, Saint Mary's College of California, <sup>4</sup>Biomedical Sciences, AA Dugoni School of Dentistry, University of the Pacific

Ontogenetic studies of ancient humans are carried out with reference to variably sized sample populations. Depending on sample size and age range studied a decision to subdivide the sample into age groups or use it as a single group may need to be made. Using an age-restricted human sample we compare metric and 3D landmark data to investigate the amount, direction, and significance of growth changes and their impact on sampling choices.

We measured 210 dimensions, calculated 36 indices, and collected 194 3D landmarks from 39 skulls (Institute for Craniofacial Study, UOP). The sample comprises 6.0-8.0-year-olds, based on tooth calcification. Means, standard deviations, and ranges were employed to explore changes in the x-y data. In 3/9 thicknesses, 1/7 subtenses, 39/194 curves, breadths, chords, or lengths, and 9/36 indices the results showed growth changes but these lacked shared extent or directionality. 3D coordinate data were analyzed with Morphologika. Shape was explored using Principle Components Analysis on Procrustes-aligned shape variables. PC1 explains 14.1% of the variance, while PC2-PC3 explain 9.7 and 8.1%, respectively. While age distributions overlapped substantially some directionality based on age was apparent in PC1-PC4.

Our standard metric assessment showed specific dimensional changes but the direction and extent of change varied. A decision was made to group this sample. Subsequent principle components analysis, however, revealed slight but clear directionality in the growth changes. While both data sets revealed ontogenetic changes, the 3D data provided clearer understanding of correlated growth changes in a wider set of dimensions.

### Variation in skin reflectance and pigmentation genes in young adults of Xhosa and Cape Mixed ancestry from the Western Cape, South Africa

NINA G. JABLONSKI<sup>1,2</sup>, TINA LASISI<sup>1</sup>, ABHIMANYU ABHIMANYU<sup>3</sup>, ANNA K. COUSSENS<sup>3</sup>, CELESTE E. NAUDE<sup>4</sup>, GEORGE CHAPLIN<sup>1,2</sup>, LAUREL N. PEARSON<sup>1</sup>, RENE GOLIATH<sup>3</sup>, MARK D. SHRIVER<sup>1</sup> and ROBERT J. WILKINSON<sup>3</sup>

<sup>1</sup>Anthropology, The Pennsylvania State University, <sup>2</sup>Research, Stellenbosch Institute for Advanced Study, <sup>3</sup>Institute of Infectious Disease and Molecular Medicine, University of Cape Town, <sup>4</sup>Centre for Evidence-based Health Care, Stellenbosch Institute for Advanced Study

In this study, we investigated the relationship between skin pigmentation, UVB exposure, and cutaneous vitamin D production in healthy young adults under non-laboratory conditions. We chose to study people in the Western Cape province of South Africa because the region has a seasonal pattern of UVB exposure and because it has a heterogeneous population, which reflects centuries of migration and genetic admixture. We selected 50 healthy young adults from neighboring populations of the Cape Flats near Cape Town, designated the Xhosa and Cape Mixed cohorts. Physical examination, skin reflectance measurements, administration of dietary and sun exposure surveys, and phlebotomy were conducted on both cohorts in late January/early February 2013 (after the solar UVB maximum) and in late July/early August 2013 (after the solar UVB minimum). As described elsewhere

(Coussens, A.K. *et al.*, 2015, *PNAS* 112: 8052–8057), both populations exhibited seasonal fluctuations in vitamin D levels and high prevalence of winter vitamin D deficiency. By exploring within- and between-population variation in skin reflectance and pigmentation genes in the current study, we sought to better understand the relationships between pigmentation genotype and phenotype (including tanning potential), and between genes affecting skin pigmentation and vitamin D metabolism. Extensive overlap in the ranges of skin reflectance measurements between the two populations was discovered, with the Xhosa cohort being darker and exhibiting lower variance in measurements than the Cape Mixed cohort. This pattern was mirrored in pigmentation SNPs, which reflected the predicted higher level of genetic admixture in the Cape Mixed cohort.

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### Primate Health Responses to Extreme Drought in Northwestern Costa Rica

KATHARINE M. JACK<sup>1</sup>, STEPHEN A. CORTESE<sup>2</sup>, GILLIAN L. KING-BAILEY<sup>1</sup>, MACKENZIE BERGSTROM<sup>3</sup> and LINDA M. FEDIGAN<sup>3</sup>

<sup>1</sup>Anthropology, Tulane University, <sup>2</sup>Ecology and Evolutionary Biology, Tulane University, <sup>3</sup>Anthropology and Archaeology, University of Calgary

Documenting the responses of wildlife can be helpful in predicting and understanding human responses to environmental degradation caused by climate change. However, surprisingly little has been documented in relation to climate change and the health of wildlife. In this study, we investigate the health effects of extreme drought on a species of wild Neotropical primate, *Cebus capucinus imitator*, in the Santa Rosa Sector of the Área de Conservación Guanacaste, Costa Rica. Average yearly rainfall from 1979-2015 was 1800mm, but 2015 was a record drought year with only 660mm. We non-invasively caught urine from habituated individuals residing in three long-term study groups and conducted in-field urinalysis using urine dipsticks. We compared results for samples collected pre-drought (June 2010, n=87) to those collected post-drought (June 2016, n=32). Of the ten health markers investigated, six differed between years: the presence of leukocytes and ketones were more common in the 2010 samples, while protein (38% in 2016 vs. 20% in 2010), blood (above trace levels; 50% in 2016 vs. 9% in 2010), and bilirubin (22% in 2016 vs. 0% in 2010) were more common in the 2016 samples. With a mean specific gravity of 1.015 in the 2016 samples (1.022 in 2010), the increased proportion of samples with the presence of blood, proteins, and bilirubin are not due

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to increased urine concentration. Rather, these results indicate that the health of our study population declined between the pre and post-drought sampling periods.

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## Variation in Lemur Color Vision across Species, Populations and Habitats: Implications for Signal Evolution

RACHEL L. JACOBS<sup>1,2</sup>, TAMMIE S. MACFIE<sup>3</sup>, JASON M. KAMILAR<sup>4</sup>, AMANDA N. SPRIGGS<sup>5</sup>, ANDREA L. BADEN<sup>2,6,7,8</sup>, TONI L. MORELLI<sup>10,2,9</sup>, MITCHELL T. IRWIN<sup>11</sup>, RICHARD R. LAWLER<sup>12</sup>, JENNIFER PASTORINI<sup>13</sup>, MIREYA MAYOR<sup>2</sup>, MICHELLE L. SAUTHER<sup>14</sup>, RUNHUA LEI<sup>15</sup>, RYAN CULLIGAN<sup>15</sup>, MELISSA T.R. HAWKINS<sup>15</sup>, PETER M. KAPPELER<sup>16</sup>, PATRICIA C. WRIGHT<sup>17,2</sup>, EDWARD E. LOUIS JR<sup>15</sup>, NICHOLAS I. MUNDT<sup>9</sup> and BRENDA J. BRADLEY<sup>1</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>2</sup>Centre ValBio Research Station, Ranomafana, Madagascar, <sup>3</sup>Department of Zoology, University of Cambridge, <sup>4</sup>Department of Anthropology, University of Massachusetts Amherst, <sup>5</sup>Department of Anthropology, University at Albany-SUNY, <sup>6</sup>Department of Anthropology, Hunter College, <sup>7</sup>The Graduate Center of City University of New York, <sup>8</sup>The New York Consortium of Evolutionary Primatology (NYCEP), <sup>9</sup>Department of Interior Northeast Climate Science Center, <sup>10</sup>Department of Environmental Conservation, University of Massachusetts Amherst, <sup>11</sup>Department of Anthropology, Northern Illinois University, <sup>12</sup>Department of Sociology and Anthropology, James Madison University, <sup>13</sup>Anthropologisches Institut, Universität Zürich, <sup>14</sup>Department of Anthropology, University of Colorado Boulder, <sup>15</sup>Conservation Genetics Department, Omaha's Henry Doorly Zoo and Aquarium, <sup>16</sup>Behavioural Ecology and Sociobiology Unit, German Primate Center, <sup>17</sup>Department of Anthropology, Stony Brook University

Primates have well-developed visual systems, and many species have the capacity for trichromatic color vision. This derived visual trait is likely adaptive, allowing for improved detection of visual signals (e.g., fruit color, conspecific coloration), which in turn likely influences the evolution of these perceived stimuli. Understanding these complex, potentially coevolutionary relationships requires consideration of the ecological, demographic, and phenotypic factors that shape selection on primate color vision. Lemurs represent an ideal system to address such questions. They are ecologically diverse with extensive variation in pelage coloration, and they are known to exhibit a wide range of color vision capacities (monochromacy, dichromacy, polymorphic trichromacy). We sequenced the X-linked opsin gene to determine color vision in 425 individuals representing 20 lemur species across 21 sites

in Madagascar. We identified extensive variation both across and within species, including variation in color vision capacity among different populations of the same species. We used phylogenetic generalized least squares analyses to assess the extent to which color vision capacity is influenced by phenotypic (pelage coloration) and local ecological pressures. Our results suggest that the best predictors of variation in lemur color vision are activity pattern, habitat, diet, and conspecific coloration. Accordingly, lemur color vision capacity appears to be influenced by potential visual signals (plant and conspecific), as well as the environments in which they are perceived. Given that visual systems and signals are likely to coevolve, variation in lemur color vision across populations might influence local variation in plant and conspecific signaling patterns.

## An Assessment of the Mandibular Ontogeny of *Limnopithecus Evansi*

AMBER C. JAEGER<sup>1</sup>, RYAN P. KNIGGE<sup>1</sup>, KIERAN P. MCNULTY<sup>1</sup>, EMMA N. MBUA<sup>2</sup>, FREDRICK K. MANTHI<sup>2</sup> and ISAIAH O. NENGO<sup>3</sup>

<sup>1</sup>Anthropology, University of Minnesota, <sup>2</sup>Earth Sciences, National Museums of Kenya, <sup>3</sup>Anthropology, De Anza College

Recent discovery of two fossil catarrhine mandibles, provisionally attributed to *Limnopithecus evansi* (adult: KNM-SO 54570, juvenile: KNM-SO 38041), provides a rare opportunity to study the ontogeny of a primate species phylogenetically positioned near the base of the hominoid clade. A comparative ontogenetic sample of extant catarrhines, including *Macaca fascicularis* (N=40), *Pan troglodytes* (N=40), *Pan paniscus* (N=40), and *Gorilla gorilla* (N=35), was used to assess whether *L. evansi* followed an ontogenetic trajectory more similar to extant Old World monkeys or to modern apes. Each ontogenetic series was represented by four dental stages with approximately ten specimens in each stage. Results of bivariate regression analyses of corpus and symphyseal dimensions against size revealed similar trends in all extant species: symphyseal dimensions remain nearly isometric across growth whereas there is an increase in corpus height relative to width as size increases. On the contrary, the ontogenetic pattern reconstructed from these fossils was considerably different. This discrepancy raises two possible conclusions: 1) the mandibular ontogeny of *L. evansi*, perhaps emblematic of other stem catarrhines, was substantially different from that of crown catarrhines, or 2) these fossil specimens do not belong to the same species. Extending our comparative sample should clarify whether the first conclusion is valid. If the latter situation is true, however, it underscores the need for a revised alpha-taxonomy of early Miocene small catarrhines based on the many new specimens collected in the last 3 decades.

This research was funded by the Leakey Foundation (ION), Fulbright Scholar Research Program (ION), and National Science Foundation (KPM).

## Reciprocity can Explain Grooming, but not other Forms of Cooperation, among Female Bonobos at LuiKotale, DRC

ADRIAN V. JAEGGI<sup>1</sup>, LIZA R. MOSCOVICE<sup>1</sup>, LUCAS G. GOLDSTONE<sup>2</sup>, GOTTFRIED HOHMANN<sup>3</sup> and BARBARA FRUTH<sup>4</sup>

<sup>1</sup>Anthropology, Emory University, <sup>2</sup>Biology, Ludwig Maximilian University Munich, <sup>3</sup>Primatology, Max Planck Institute for Evolutionary Anthropology, <sup>4</sup>Natural Sciences and Psychology, Liverpool John Moores University

Reciprocal altruism is the main theory proposed to explain the evolution of cooperation among unrelated individuals, in the absence of immediate benefits. In many non-human species individuals cooperate more with those from whom they receive more cooperation over the long-term. Chimpanzees and bonobos often cooperate among non-kin, suggesting the possibility of high levels of reciprocal altruism in these species. Indeed, there is good evidence for reciprocal exchange of grooming, coalitionary support, or food sharing among chimpanzees. In contrast, several studies have failed to find evidence for reciprocity in bonobos. The goals for this study were to test for long-term exchange or interchange of cooperation specifically among female bonobos, who exhibit high levels of cooperation despite being the dispersing sex. Over 14 months between 2013-2014, we collected focal continuous and *ad libitum* data on grooming, food sharing and coalitionary support from all N=13 adult female residents of the Bompusa community at LuiKotale, DRC. Cooperation given and received was corrected for differences in individual observation time and dyadic co-occurrence in parties. We built linear and generalized linear mixed models to test whether grooming, support or food given were predicted by amounts of cooperation received, while controlling for kinship and rank. Results indicate reciprocal exchange of grooming, but no evidence for reciprocity in support or food sharing, nor interchange of one form of cooperation for another. Our results are consistent with previous research on bonobos and indicate that benefits other than reciprocity are needed to explain cooperation outside of kinship among female bonobos.

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## ABSTRACTS

### Tooth Avulsion, Identity and Funerary Archaeology at Al Khiday 2, Central Sudan

TINA JAKOB<sup>1</sup>, JOE W. WALSER III<sup>2,3</sup>, DONATELLA USAI<sup>4</sup> and SANDRO SALVATORI<sup>4</sup>

<sup>1</sup>Department of Archaeology, Durham University, United Kingdom, <sup>2</sup>Department of Archaeology, The University of Iceland, <sup>3</sup>National Museum of Iceland, Setberg, Iceland, <sup>4</sup>Centro Studi Sudanese Sub-Sahariani, Trevio, Italy

Deliberate removal of healthy teeth during life (also termed tooth avulsion, evulsion or ablation) has been reported in numerous archaeological populations irrespective of cultural background, time period and geographical location. In our contribution we are presenting data on tooth avulsion from the multi-phase cemetery of Al Khiday 2, located on the western bank of the White Nile, approximately 20km south of Omdurman (Khartoum). The three phases of use of the cemetery date to the Classic/Late Meroitic (end of the 1st millennium BCE/beginning of the 1st millennium CE), the early Neolithic (mid-5th millennium BCE) and pre-Mesolithic (12.700/11.100-6750 BCE) periods.

Tooth avulsion was observed in the majority of the 94 pre-Mesolithic individuals, involving the maxillary central incisors. However, only three of the 32 Neolithic individuals had avulsed teeth, targeting the mandibular central incisors, while none of the 43 Meroitic individuals showed evidence of avulsion practices. We investigated whether there was a correlation between biological sex and tooth avulsion in combination with funerary settings (grave orientation and placement of the body within the grave) to identify potential patterns of cultural identity in these diachronic groups, but found no specific pattern probably due to an almost uniform burial rite for the pre-Mesolithic population, with prone burial being the preferred body position, but no discernible preferential orientation. Further comparisons were made with published examples of tooth avulsion from along the Nile Valley (e.g., Ginefab School, Sudan) and late Pleistocene and early Holocene populations (e.g., Afalou-bou-Rhumel, Algeria and Gobero, Niger) in Northern Africa.

### The confusing case of Grave 42: a bioarchaeological analysis

COCO JAMES<sup>1</sup>, KATHLEEN FLOR-STAGNATO<sup>2</sup>, ERICA CANTOR<sup>3</sup>, ANNA J. OSTERHOLTZ<sup>4</sup>, ANDRE GONCIAR<sup>5</sup> and ZSOLT NYÁRÁDI<sup>6</sup>

<sup>1</sup>School of Archaeology and Anthropology, The Australian National University, <sup>2</sup>Anthropology, Texas State University, <sup>3</sup>Human Biology, University of Indianapolis, <sup>4</sup>Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>5</sup>Archaeotek, Archaeotek, <sup>6</sup>Haáz Rezső Múzeum, Haáz Rezső Múzeum

Grave 42 is an atypical burial uncovered within the Varosfalva cemetery during fieldwork in 2016

in Transylvania, Romania. The skeleton of Grave 42 was found in a semi-prone, extended position. Grave 42 is extremely well preserved, which is consistent with the Varosfalva site; however both the positioning of the skeleton and the quantity of grave goods and hardware is unique. Excellent preservation has conserved many of these associated goods, including coins, buttons, leather, coffin wood, coffin nails, and other coffin hardware which date this burial to the 19th Century. The skeleton is mostly complete, estimated to be a male between twenty-seven and thirty-four years old. Evidence of healed blunt forced trauma is present on the right parietal, along with a healed fracture on the right nasal bone. Grave 42 represents a potentially atypical burial within this cemetery, due to its semi-prone positioning. While many burials in this cemetery included grave goods, this individual appears to be more wealthy than others there and is buried in an unusual way: face down. In this paper we will explore what this atypical burial represents in regards to wealth and status within the local community and determine the reasoning for the atypical positioning of the remains.

### Does menstrual phase affect the relationships between catecholamines and perceived environmental stress?

GARY D. JAMES

Anthropology, Binghamton University

The results of studies examining the relationship between catecholamine (epinephrine (Epi) and norepinephrine (NE)) excretion and perceived stress during the day in women are contradictory. One reason for the inconsistency may be that the relationships are affected by the phase of the menstrual cycle when measurements are made. The purpose of this study was to compare the relationships between changes in perceived daily environmental stress and Epi and NE excretion between the follicular and luteal phases of the menstrual cycle (MC) in 71 women (mean age=34.9±7.7 yrs.) who all worked in clerical, technical, or professional positions at a major medical center in NYC. Each woman was studied on a mid-follicular (day 8±2) and mid-luteal (day 22±2) day of their MC. Perceived stress at work and home was measured on a 0-10 scale; women were classified as work stressed (WS) or home stressed (HS) on each day based on the difference in work-home stress designation. The rates of Epi and NE excretion were compared across work (11AM-3PM), home (approx. 6PM-10PM) and sleep (approx. 10PM- 6AM) environments, MC phase and WS/HS designation using repeated measures ANOVA models. The results show that in both phases of the cycle, Epi and NE excretion is highest at work and lowest during sleep ( $p < .001$ ) in both WS and HS women; however, in the follicular phase, Epi at home among HS women is elevated relative to

WS women ( $p < .084$ ). These findings suggest that the Epi- perceived stress relationships may vary over the MC.

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### A phylogeny of the CHIA gene in the context of insectivory

MAREIKE C. JANIÁK<sup>1</sup>, MORGAN E. CHANEY<sup>2</sup> and ANTHONY J. TOSI<sup>2</sup>

<sup>1</sup>Department of Anthropology, Rutgers University, <sup>2</sup>Department of Anthropology, Kent State University

Insects are an important food resource for many primates. However, the chitinous exoskeletons of insects may reduce the value of this food source because chitin, a structural polysaccharide similar in structure to cellulose, is indigestible in the absence of a specialized enzyme. Insectivorous bats produce the chitinolytic digestive enzyme acidic mammalian chitinase (AMCase) in the stomach in order to digest insect exoskeletons. Thus, expressing a functional AMCase in the gut may also be an important adaptation for insectivorous primates. The gene *CHIA* encodes AMCase, offering a minimally invasive method for studying this gut enzyme in primates. We mined published genomes of *Macaca*, *Gorilla*, *Papio*, *Pongo*, and two insectivorous bats for *CHIA* and sequenced the gene in a number of additional primate species with varying levels of annual insect consumption: From high (*Tarsius*, *Saimiri*, *Cebus*) and medium (*Callithrix*, *Aotus*, *Saguinus*, *Erythrocebus*, *Allochocebus*, *Miopithecus*, *Allenopithecus*) levels to no insect intake (*Colobus*, *Alouatta*). A sanguivorous bat (*Desmodus rotundus*) was also sequenced to provide a non-insectivorous bat comparison. Preliminary analyses suggest that the *CHIA* amino acid sequences, but not the nucleotide sequences, of insectivorous primate species are more similar to those of insectivorous bats than those of other primates. This indicates that there may have been convergence in digestive enzyme function between two groups of mammals in response to similar diets.

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### Human remains and artefacts from Romualdo's cave, Istria, Croatia

IVOR JANKOVIĆ<sup>1,2</sup>, JAMES C.M. AHERN<sup>3</sup>, DARKO KOMŠO<sup>3</sup>, SANJIN MIHELIC<sup>4</sup> and FRED H. SMITH<sup>5</sup>

<sup>1</sup>, Institute for Anthropological Research, <sup>2</sup>Department of Anthropology, University of Wyoming, <sup>3</sup>, Archaeological Museum of Istria, <sup>4</sup>, Archaeological Museum in Zagreb, <sup>5</sup>Department of Anthropology and Sociology, Illinois State University

Romualdo's cave is located on the southern slopes of the Lim channel in Istria, Croatia. It was recognized as potentially interesting

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archaeological site in the late 19th century when several researchers led small-scale excavations in the cave. In the mid 20th century M. Malez conducted more extensive excavations of the site and unearthed various archaeological and paleontological material dating from the Late Pleistocene to the Bronze and Iron Ages. The Late Pleistocene finds included Upper Paleolithic types of tools, faunal remains and two juvenile human teeth. In 2007 and 2008 D. Komšo led small scale excavations during which several Mousterian-like artefacts were found. In 2014 new excavations of the site started as a part of the ARCHAOLIM (Archaeological Investigations into Late Pleistocene and Early Holocene of the Lim Channel, Istria) financed by the Croatian Science Foundation. During the three years of work at the site, human skeletal material and artefacts from Bronze Age, as well as artefacts from Iron age were found. The lower sequence yielded Musterian artefacts and Pleistocene faunal remains dated to over 48 kya. Here we report the basic findings of these excavations, as well as analysis of the skeletal remains. The Upper Paleolithic associated deciduous teeth are fully modern and add to our knowledge of Upper Paleolithic humans in East Central Europe.

*The ARCHAOLIM project (Archaeological Investigations into Late Pleistocene and Early Holocene of the Lim Channel, Istria) is financed by the Croatian Science Foundation.*

### New Small Catarrhine Fossils from Songhor and Lower Kapurtay and their Implications for Interpreting Early Miocene Primate Communities

RUTGER J. W. JANSMA<sup>1</sup>, ISAIAH O. NENGO<sup>2</sup>, KIERAN P. McNULTY<sup>1</sup>, SUSANNE COTE<sup>3</sup>, NASSER MALIT<sup>4</sup> and NANCY J. STEVENS<sup>5</sup>

<sup>1</sup>Anthropology, University of Minnesota, <sup>2</sup>Anthropology, De Anza College, <sup>3</sup>Anthropology and Archaeology, University of Calgary, <sup>4</sup>Anthropology, SUNY College at Potsdam, <sup>5</sup>Biomedical Sciences, Ohio University

The early Miocene localities Songhor and Lower Kapurtay (~19.5 Ma) have yielded new small-bodied catarrhine fossils that play a critical role in assessing taxonomic diversity and regional endemism among penecontemporaneous primate communities. The new material consists of 38 dentognathic specimens, including a partial maxilla, several mandibles, and numerous isolated adult and deciduous teeth. Previous workers have recognized three small catarrhine taxa at Songhor: *Limnopithecus evansi*, *Kalepithecus songhorensis*, and *Dendropithecus macinnesi*. Based upon a comprehensive examination of our new specimens and all historic collections from Songhor and Lower Kapurtay, we draw several conclusions. First, qualitative and quantitative analyses support the validity of both *K. songhorensis* and *L. evansi*, but the

hypodigm of each samples more than one taxon, including one previously unrecognized in the collections. This new taxon differs from the similar-sized *L. evansi* in having non-externally angulated canines and upper molars with more peripheralized cusps. Second, *Dendropithecus* at Songhor is both more common than previously thought and differs from the Kisingiri population in having molars with more isolated cusps and lacking a distolingually projecting distal fovea on the m2. Using this new taxonomic framework, we reexamined small catarrhine fossils at other Tindoret localities and conclude that their diversity has been underestimated both within the same time period, as well as between successive time periods. Consequently, our results provide additional support for the distinctiveness of penecontemporaneous early Miocene catarrhine communities. Overall, these new discoveries reinforce the importance of the Tindoret localities for understanding catarrhine biogeography and diversification.

### Cortical Bone Structural Variation in Modern Human Metatarsals

TEA JASHASHVILI<sup>1,2,6</sup>, MARK R. DOWDESWELL<sup>3</sup>, LYNNE A. SCHEPARTZ<sup>4,5</sup>, PATRICIA CHABIKULI<sup>4</sup>, BERNHARD ZIPFEL<sup>6</sup> and KRISTIAN J. CARLSON<sup>6,7</sup>

<sup>1</sup>Department of Geology, Georgian National Museum, <sup>2</sup>Department of Radiology, Keck School of Medicine, University of Southern California, <sup>3</sup>Statistics and Actuarial Science, University of the Witwatersrand, <sup>4</sup>HVIRU, School of Anatomical Sciences, University of the Witwatersrand, <sup>5</sup>Museum of Archaeology and Anthropology, University of Pennsylvania, <sup>6</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>7</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California

Long bone cross-sectional geometry is widely used to compare bone structural changes in response to subsistence strategies and activity patterns. Recent studies of metatarsal midshaft cross-sectional properties found few differences between presumed unshod and shod groups. Here we investigate entire metatarsal diaphyses in order to test the hypothesis that presumed footwear use does not differentiate metatarsal internal structure. Metatarsal sets from 45 individuals representing Later Stone Age (LSA) foragers (15 Fynbos biome, 15 Forest biome) and 15 black South Africans from the RA Dart Collection were analyzed for cortical bone thicknesses (CBT) and second moments of area (SMA) using high resolution images. A color map approach and penalised discriminant analysis were performed in order to visualize and quantitatively assess group-specific patterns.

The complete shafts of 1<sup>st</sup> and 5<sup>th</sup> metatarsals exhibit major differences proximally or distally, which are probably linked to kinematic differences responsible for loading differences during gait. In assessing structural variation within all

five metatarsals, there appear to be differing influences of terrain as well as foot wear patterns. Greater CBTs are observed for the LSA groups compared to the Dart samples, and mediolateral reinforcement is also pronounced in the former. SMA results display similar patterns amongst the groups except that LSA foragers demonstrate elevated values overall. Increased resistance to repetitive loading reflects elevated mobility in the LSA groups. These findings could have useful implications for evaluating sets of hominin metatarsals.

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### Paternal grandmothers increase and maternal grandmothers decrease fertility of couples they reside with

GRAZYNA JASIENSKA<sup>1</sup>, MICHAL JASIENSKI<sup>2</sup>, ANDRZEJ GALBARCZYK<sup>1</sup>, ILONA NENKO<sup>1</sup> and MAGDALENA KLIMEK<sup>1</sup>

<sup>1</sup>Department of Environmental Health, Jagiellonian University, Poland, <sup>2</sup>Center for Innovatics, Nowy Sacz Business School—National-Louis University, Poland

Humans are cooperative breeders, where family members ensure their fitness benefits by influencing reproduction of relatives. Paternal grandmothers (PGM), who have lower certainty of genetic relatedness with their son's children, should promote production of higher number of grandchildren even at the cost of their lower quality. In contrast, such quantity-quality tradeoff may not apply for maternal grandmothers (MGM).

We compared reproductive patterns among three groups of married women (aged 45 and older) from rural Poland: those who lived with their own mother (MGM, N=193 families), with mother-in-law (PGM, N=283), or without either mother (N=150). Groups did not differ in waiting time to first pregnancy or age at first reproduction, which indicates that their biological potential to have children was the same. PGMs and MGMs lived, on average, for the same length of time (about 16 years) with families. However, couples who lived with PGM had 19% higher average number of children compared to couples living by themselves (5.1 v. 4.3), while the presence of MGM was associated with 14% reduction in family size (3.7). Higher parity of the PGM-families was achieved through longer reproductive span (by 2.4 years), later age at last birth (35.0 v. 32.6 years old), and marginally shorter average inter-birth intervals (28.6 v. 32.1 months). At the same time, children born to couples who lived with PGM had significantly lower Apgar scores (9.1 v. 9.4) than those living with MGM.

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Specific behavioral tactics employed by grandmothers to influence reproduction of couples are currently under study.

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### Exploring the Use of Wrist-based Fitness Monitors in Network Creation

THOMAS JASKOWIEC and MARK V. FLINN

Department of Anthropology, University of Missouri

Social networks have long been studied by many anthropologists, and the impact of network analysis has grown significantly in disease and health studies. Powerful new software and sophisticated statistical techniques could be argued to have outpaced traditional field methods for data collection. Surveys and observational studies could add certain biases to the variables and manner in which information collected. The use of wrist-based monitors offers the ability to completely change how networks are created. We show how these new devices can be used to determine social networks and certain markers of health in a sample of children in rural Dominica. Our sample consisted of 12 children that wore the wrist-based monitors (ages 5-12) for a period of 8 days. The children were instructed to continue their normal daily routines with all regular activities while wearing the monitors, with the data downloaded daily during the trial. These monitors enable us to create a network based on actual physical location to one another, and to establish the validity of the presented network. We present the baseline network in this sample, and examine how this can be expanded to village-level analyses on social networks, physical activity, and disease transmission through contact exposure. Using this method, researchers will be able to track a host of biological and physical individual variables to use in any number of disease or health studies.

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### Households at the edge of Europe: A reexamination

JULIA A. JENNINGS

Anthropology, University at Albany

Research on the historical demography of Northwest Europe has emphasized the ubiquity of small, simple family households through much of the documented past. However, in North Orkney, Scotland, nineteenth century documentary evidence and historical archaeology have indicated that larger complex households were more common than expected for this part of Europe (60% complex households in North Orkney in 1851, 12-23% among a sample of

English counties in 1851). This study examines potential causes of this variation in household composition, including environmental and economic adaptation, and the potential consequences of complex households with respect to the human population ecology of these remote islands. The proportion of complex households decreases slightly as the population of the islands declines, suggesting that farm division and land scarcity, along with within-household demographic dynamics, contribute to household complexity. The aged and impoverished are more likely to live in complex households than simple households, suggesting, together with evidence from mortality and fertility analyses, that the inhabitants of these islands experienced low standard of living in the nineteenth century. Complex household living arrangements may have been one response to household economic or demographic stress.

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### Homoplasmy in papionins: an explanation from genetic sources of variation shared by body size and craniofacial form

JESSICA L. JOGANIC<sup>1</sup>, KATHERINE E. WILLMORE<sup>2</sup>, JOAN T. RICHTSMIEIER<sup>3</sup>, LAURA A. COX<sup>4,5</sup>, MICHAEL C. MAHANEY<sup>6</sup>, JEFFREY ROGERS<sup>7</sup> and JAMES M. CHEVERUD<sup>8</sup>

<sup>1</sup>UMR5199 PACEA, University of Bordeaux, <sup>2</sup>Dept. of Anatomy and Cell Biology, The University of Western Ontario, <sup>3</sup>Dept. of Anthropology, Pennsylvania State University, <sup>4</sup>Dept. of Genetics, Texas Biomedical Research Institute, <sup>5</sup>Southwest National Primate Research Center, Texas Biomedical Research Institute, <sup>6</sup>South Texas Diabetes and Obesity Institute, University of Texas Rio Grande Valley School of Medicine, <sup>7</sup>Human Genome Sequencing Center, Baylor College of Medicine, <sup>8</sup>Dept. of Biology, Loyola University Chicago

Papionini is characterized by convergence of two large-bodied taxa (*Mandrillus*, *Papio/Theropithecus*) from a macaque-like common ancestor. These taxa possess remarkably similar craniofacial anatomy—exceedingly large canines with correspondingly long snouts—and demonstrate extreme sexual dimorphism in craniofacial form and body size. Although many have speculated that sexual selection is the driving force behind both evolutionary trends, it is unclear if and how the two are correlated and what the biological basis of any interrelationship might be. Here, we present evidence to suggest that a portion of the genetic variation underlying body size and craniofacial shape variation is shared and, thus, selection on one likely also affects the other. We collected data for 28 craniometric landmarks to produce 60 linear dimensions that quantify size and shape variation in 985 baboon crania. Quantitative genetic parameters were estimated for the standardized dimensions (model I). Estimates were recalculated while including body mass as a covariate to focus on craniofacial variation that is independent of allometry (model II).

Finally, skull size was included to recalculate estimates for shape-specific craniofacial variation (model III). Additive genetic variance decreases after removing size-related variation ( $V_{ai} = 0.46 \pm 1.4$ ,  $V_{aII} = 0.41 \pm 1.4$ ,  $V_{aIII} = 0.32 \pm 1.4$ ), and about a third of the genetic variation contributing to body size variation also affects craniofacial variation (mean  $\rho_G = 0.35$ ). These results suggest future studies would benefit from considering craniofacial evolution in conjunction with that of body size and urges caution in choosing between methods of “correcting for” allometric variation.

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### Male infants, risk, and postnatal depression: Evidence regarding the Trivers-Willard hypothesis in a contemporary low-fertility context

SARAH E. JOHNS and SARAH MYERS

School of Anthropology and Conservation, University of Kent

Maternal care is obligate in mammals to ensure offspring survival; however levels of investment are flexible, dependent on resource availability. Parental investment theory predicts that a mother should cease investing in an individual offspring when the benefits of the investment to her inclusive fitness are outweighed by the costs. The Trivers-Willard hypothesis predicts that a son of high quality will out-reproduce a daughter of comparable quality, while a daughter will have higher reproductive success than a son if both are of low quality. Postnatal depression has been suggested to reflect active withdrawal of maternal investment in humans under conditions where continued investment is too costly. If this is the case, then it should be more common under such circumstances, and thus conform to Trivers-Willard predictions and be more common in association with sons than daughters. Regression modelling, using data from a survey of the complete reproductive histories of postmenopausal women, showed the birth of a son elevated postnatal depression risk when mothers experienced relatively low, but not the lowest, level of socioeconomic status or complicated births. Incidence in relation to other postnatal depression risk factors was the same across the sexes. Identifying risk factors for postnatal depression is important for prevention. An increased risk of postnatal depression after the birth of sons is not currently recognised, and the association between postnatal depression, birth complications and infants of male sex is a novel and important finding, of which healthcare professionals should be made aware.

# ABSTRACTS

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## The Multidimensional Nutritional Niche of Baboons

CALEY A. JOHNSON<sup>1,2</sup>, DAVID RAUBENHEIMER<sup>3</sup> and JESSICA M. ROTHMAN<sup>1,2,4</sup>

<sup>1</sup>Anthropology, Graduate Center of CUNY, <sup>2</sup>NYCEP, New York Consortium in Evolutionary Primatology, <sup>3</sup>Charles Perkins Centre, The University of Sydney, <sup>4</sup>Anthropology, Hunter College of CUNY

Nutrient intake is an important factor determining health, longevity, and reproductive output. The intake of nutrients by consumers is the product of consumer biology engaging with qualitative and quantitative variation in food availability, an interaction often modelled as a "nutritional niche." We attempt to operationalize the nutritional niche of baboons using the right-angled mixture triangle (RMT), in a manner similar to the Hutchinsonian niche concept. Using the RMT, we constructed 3-dimensional nutritional niches based on the macronutrients that contribute to metabolizable energy of foods ("food composition niche"), and dietary intakes of adult female olive baboons ("fundamental macronutrient niche"). We collected these data from nutrient analyses of 512 foods, and 320 full-day focal follows in Kibale National Park, Uganda, between 2013-2014. We found that the protein and carbohydrate space occupied by foods was extensive, with 90% and 94% of possible space occupied. The fundamental macronutrient niche occupied the lower range of protein (3-53%) and the upper range of carbohydrate food space (23-92%). As fats were limited in foods, the food composition niche occupied the lower 58% of potential lipid space, and diet intakes included this entire range. The total 3-D area of the RMT occupied by baboon foods was 42%, while 26% was occupied by dietary intakes. While we know baboons are ecological generalists and as a result are one of the most widespread primate species, more comparative data on nutritional niches across taxa are needed to contextualize the extent of their generalism, and ability to partition space with other species.

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## Social network analysis of cranial shape among Moquegua Tiwanaku-affiliated communities: a regional approach to kinship analysis

KENT M. JOHNSON

School of Human Evolution and Social Change, Arizona State University

Bioarchaeologists have embraced social identity theory as a flexible framework for investigating social organization, but flexible analytical methods for investigating patterns of affiliation and interaction that are grounded in social theory are underdeveloped. This paper applies social network analysis to phenotypic data from

samples of human skeletal remains from Middle Horizon period (AD 500-1100) Tiwanaku-affiliated colonies in the Moquegua Valley, Peru to investigate family-based aspects of social organization.

Social network visualization and analytical techniques were applied to basicranial and temporal bone shape data from 102 individuals from five sites to assess phenotypic similarity and identify potential clusters of close biological relatives. Results of social network analysis are compared to results of agglomerative hierarchical cluster analysis and multidimensional scaling to evaluate the use of social network techniques with phenotypic data.

Results indicate the study sample formed a network with a dense main component and numerous isolated individuals. Efforts to identify potential family groups using social network analysis had mixed success. While there is no clear partition of the network into distinct subgroups representing different extended family networks, there is a cluster of closely related individuals at the core of the network who anchor an interconnected web of less closely related actors. Agglomerative hierarchical clustering produced similar results, but multidimensional scaling was unable to identify subgroups within three-dimensional representation space. Results suggest that social network analysis can scale up kinship analysis to investigate family-based social organization at a regional scale. More broadly, social network techniques have myriad potential applications within bioarchaeology.

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## Hand and Foot Postures during Vertical Clinging and Grasping: Implications for Digit Length in Primates

LAURA E. JOHNSON<sup>1</sup> and DANIEL SCHMITT<sup>2</sup>

<sup>1</sup>Pathology and Anatomy, University of Missouri, <sup>2</sup>Evolutionary Anthropology, Duke

The nail-bearing hands and feet of primates present biomechanical challenges when clinging to vertical tree trunks since they cannot dig claws into, or adhere to, its surface. Instead primates must grasp a vertical support, and the upper limb must cope with a moment (M) pushing the upper body backwards. However, hand and foot posture will influence these mechanics, which we also hypothesize will vary with body mass, locomotor mode, and substrate size. To study this, 21 individuals of eight strepsirrhine species from the Duke Lemur Center ranging in mass from 150g-4000g with differing habitual locomotor modes were prompted to vertically cling and grasp on clear PVC pipes of three sizes. Animals were filmed with two cameras. Angles were calculated for the hand (between the tip of the pollex, wrist, and digit II) and for the foot (between the hallux, ankle,

and tip of digit II). These were compared by body mass, locomotor mode, and substrate size with Kruskal-Wallis tests. Contrary to expectations, hand angles did not differ with substrate size, (medians from small-large: 50°, 51°, 47°). Foot angles were observed to significantly increase with substrate size, as expected (medians from small-large: 37°, 45°, 51°). That hand angle did not increase can be related to an increase in M, as the pollex would be in a position to increase M, not reduce it. As such, these data suggest mobile, long pollices are not optimal for grasping large vertical supports, which may explain their reduction in many arboreal primates.

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## Evidence for violence along the Silk Road (206 BCE-420 CE), in Xinjiang Province, China

MEGAN JOHNSON, MARIANA SANTOS, ARIEL GARCIA, CECILIA SEPULVEDA and CHRISTINE LEE  
Anthropology, California State University, Los Angeles

Yanghai and Yingpan were two desert oasis sites in the Turfan basin in modern day western China. These sites were located close together, along the lucrative Silk Road. This region was known for growing wood to make bows, grapes to make wine, and cannabis for shamanistic ceremonies. A total of 97 individuals from Yingpan (46) and Yanghai (51) were analyzed for cranial trauma. At Yingpan (11) and Yanghai (10) 22% of the sample populations showed evidence of trauma. At Yanghai 8 males, 2 females, and 1 indeterminate individual had trauma to the skull. Six individuals, including the two females had broken and healed nasal or zygomatic bones. This pattern fits an interpretation of interpersonal violence. Five individuals exhibit trauma consistent with warfare. Five males had multiple sharp trauma (sword blows, arrow wounds), blunt trauma (weapons), and high velocity trauma. At Yingpan all of the individuals with trauma were male. Eight individuals had broken noses consistent with interpersonal violence. One individual had a healed injury to the top of the head. One individual had a blade injury to the left mandible. Yanghai had a slightly higher overall incidence of violence than Yingpan. This was unexpected as the military fortress for the region is at Yingpan. Possibly Yanghai's more central location along the Silk Road contributed to the pattern of stress and violence at this site.

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## Identification of Mitochondrial and Y-chromosome Population Structure among Four Aye-aye Populations in Madagascar

MEGAN L. AYLWARD<sup>1</sup>, STEIG E. JOHNSON<sup>1</sup>, GEORGE H. PERRY<sup>2,3</sup> and EDWARD E. LOUIS JR.<sup>4</sup>

<sup>1</sup>Department of Anthropology and Archaeology, University of Calgary, <sup>2</sup>Department of Anthropology, Pennsylvania State University, <sup>3</sup>Center for

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Comparative Genomics and Bioinformatics, Pennsylvania State University, <sup>4</sup>Grewcock Center for Conservation and Research, Omaha's Henry Doorly Zoo and Aquarium

The aye-aye is listed as one of the world's 25 most endangered primates, in large part due to fragmentation of their habitat. To protect aye-ayes, it is important to reconnect and maintain gene flow between historically connected populations. To better prioritize habitat conservation and restoration, we must identify the mechanisms for gene flow between populations. Previous research has shown high levels of differentiation between three northern aye-aye populations. Also, ranging patterns differ between sexes in this species; female home ranges are smaller than males' and do not overlap other females', whereas male ranges are large and overlap with both males and females. The large travel distances observed in males may reflect differences in dispersal patterns between the sexes.

We used blood (n=5) and faecal (n=3) samples from eight wild aye-aye from four populations in northern and eastern Madagascar. We identified 146 and 224 informative SNPs in the paternally-inherited Y-chromosome and maternally-inherited mtGenome respectively, and genotyped individuals using these loci. We used the *phylogenetic tree* tool in Galaxy to calculate pairwise genetic distance between all sampled individuals. Mean pairwise genetic distance based on mitochondrial markers was 0.68 compared to 0.37 in Y-chromosomal markers. In particular, mitochondrial loci revealed high genetic distance between individuals from two eastern populations, whereas Y-chromosomal loci revealed low genetic distance between these populations. Incongruence between marker types may reflect male-biased dispersal in aye-ayes. Low distance between paternally-inherited markers may indicate historic connectivity along the eastern rainforest corridor, which should be considered in conservation planning.

### Shape differences in the proximal femur of a cadaver sample based on different classifiers of obesity

ROB'YN A. JOHNSTON, LIBBY W. COWGILL and TAYLOR PASKOFF

Anthropology, University of Missouri

Femoral cross-sectional area (TA) changes with variation in body mass. In particular, increased proximal femur TA has been associated with obesity, as based on body mass index (BMI) (Moore, 2008). There are many critiques of BMI as a tool for identifying obesity, particularly that BMI may mask variation in body composition. This project investigates whether the same differences in proximal femoral TA are present using one skeletal and two soft-tissue methods for identifying obesity. Twenty-five cadavers were

classified as obese or normal weight using three methods: body fat percentage (BF%) using soft-tissue circumference measurements, waist-hip ratio (WHR) following WHO guidelines, and BMI calculated from femoral head and bi-epicondylar breadth. The method of classifying individuals as obese dramatically affected the proportion of obese individuals in the sample. 2/25 individuals were obese using BMI, 9/25 using WHR, and 13/25 using BF%. The TA was significantly different ( $p < 0.01$ ) at the proximal femur using BF%, but not for WHR or BMI. This may be a factor of sample size, particularly for BMI where  $n_{obese} = 2$ . This project suggests that increased waist breadth is not the cause of increased TA, and that it may instead be related to body composition, specifically the relative amount of muscle mass versus fat.

### Connected Lives: Maternal Health in Medieval and Post-medieval England

AMANDA C. JONES<sup>1</sup> and TINA JAKOB<sup>2</sup>

<sup>1</sup>Wisconsin Historical Society-Museum Archaeology Program, <sup>2</sup>Department of Archaeology, Durham University

This contribution investigated the impact of urbanization on maternal health in post-medieval England. **Methods:** We used prenatal and postnatal human skeletal remains as a proxy for maternal health. Taking a population-based bioarchaeological approach, this study examined the health of 734 fetal (<40 gestation weeks), neonatal ( $\geq 40$  to 44 gestational weeks) and early post-neonatal infants (1-6 months) from 29 different archaeological sites dating from the medieval (410-1550 CE) and post-medieval (1550-1850 CE) periods. This study compares prenatal and postnatal health between the medieval and the post-medieval periods, as well as between urban and rural areas, through the presence and absence of specific indicators of stress (i.e. metabolic disease, congenital, treponemal disease, dental enamel hypoplasia, and neoplastic disease) and non-specific indicators of stress (i.e. cribra orbitalia, non-specific infection, porotic hyperstosis, endocranial lesions, and Histocytosis-x). These comparisons were analyzed using a chi-square test. **Results:** The study revealed a statistically significant difference between non-adult health in medieval and post-medieval England, but no statistical difference between non-adult health in urban and rural environments. **Conclusion:** Maternal health declined in post-medieval England with the development of urbanization. There was no change in maternal health between urban and rural areas, suggesting rural settlements were not any healthier than urban environments in medieval and post-medieval England.

### What does women's facial attractiveness cue?

BENEDICT C. JONES, AMANDA C. HAHN, CLAIRE I. FISHER, MICHAL KANDRIK, HONGYI WANG, CHENGYANG HAN and LISA M. DEBRUINE

Institute of Neuroscience & Psychology, University of Glasgow

Many researchers have suggested that between-women differences in facial attractiveness reflect components of mate value, such as individual differences in susceptibility to infectious diseases, hormone levels, maternal personality, and/or adiposity. However, evidence for these relationships is mixed, sample sizes are generally small, and studies typically investigate only a single component of mate value. To address these issues, we tested for possible relationships between facial attractiveness, and salivary hormone levels (measured on five separate occasions), reported susceptibility to infectious diseases, body mass index, waist-to-hip ratio, and reported maternal personality in a sample of 250 young adult women. Of these putative components of mate value, only body mass index predicted women's facial attractiveness. Collectively, these findings underline the importance of adiposity cues for women's facial attractiveness. They also suggest that the importance of links between facial attractiveness and women's susceptibility to infectious diseases, hormone levels, and maternal personality may be overstated in the current attractiveness literature.

### The Shape of Selection on Human Life Histories

JAMES HOLLAND JONES

Department of Earth Systems Science, Stanford University

On the fitness surface defined by age-specific fertilities and survival probabilities, the direction of selection clearly points toward higher immature survival. However, what is less clear is how changes in immature survival will change the selective surface itself. In brief, the question is how does the selection gradient change as demographic traits respond to selection? Since selection is essentially a derivative (i.e., the change in fitness with respect to a change in a phenotype), the change in the selection gradient resulting from the response to selection itself is measured by second derivatives of fitness. As noted by Lande and Arnold (1983), a non-zero second cross-derivative means that selection will reduce or increase the phenotypic correlation between two traits, depending on the sign. Using age-structured demographic data from populations that span the human demographic space, I measure the local curvature of the fitness surface for human life histories, focusing in particular on the mutual effects of early survival and fertility. In all cases, correlational selection is negative for early survival with respect to later-age fertility.

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Similarly, all cases show strongly positive correlational selection for survival with respect to fertility at immediately subsequent age classes. While the results are quite consistent across populations, there is some surprising heterogeneity in correlational selection for certain traits, highlighting the need to consider the breadth of human demographic diversity when making general statements on how selection shapes human life histories.

### Harlyn Bay: A Case Study in the Analysis of a Curatorially Commingled Skeletal Collection

ALEXIS M. JORDAN

Anthropology, University of Wisconsin-Milwaukee

Curatorially commingled human remains are subject to forms and degrees of commingling, the extent of which is not seen in excavation or laboratory contexts. This case study focuses on the analysis of remains recovered from the site of Harlyn Bay, a British Iron Age (c 400 B.C. to 100 A.D.) cemetery excavated between 1900-1905 and housed at the Royal Cornwall Museum. Early use of the collection by antiquarians led to the commingling of human remains from multiple contexts within Harlyn Bay. A preliminary assessment of the collection also revealed that a subset of the remains had been commingled with other skeletal collections housed at the museum.

Consequently, prior to conducting commingled skeletal analyses to individuate the remains, additional museological and skeletal methods were employed to identify which remains could be confidently associated with Harlyn Bay. These included 1) identification and review of all available archival documentation, including notations written on/within storage containers and the remains; 2) visual assessment of the remains for notable disparities in their physical condition suggesting discrepancy in origin or history; 3) querying of museum staff and databases for additional information on the cultural identity and physical attributes of the other associated commingled collections. Through the application of these methods, the majority of the Harlyn Bay collection has been disentangled. This case study highlights the need for the development and application of additional methods to determine the form and extent of curatorial commingling prior to the individuation of remains and offers preliminary steps to achieve this goal.

*The research was supported in part by the Archaeological Institute of America Elizabeth Bartman Museum Internship Fund and the University of Wisconsin-Milwaukee Distinguished Dissertation Fellowship*

### Testing the Coimbra Method: Discovering Possible Causes of Fibrocartilaginous Enteseal Change

KELSEY C. JORGENSEN<sup>1</sup> and ELENA F. KRANIOTI<sup>2</sup>

<sup>1</sup>Anthropology, Wayne State University, <sup>2</sup>History, Classics, and Archaeology, University of Edinburgh

This research tests the Coimbra Method, an observational process created to definitively answer whether 'musculoskeletal stress markers,' or enteseal changes, can reveal information about the physical activities of skeletal remains. Several issues led previous studies to have inconclusive results on the validity of enteseal change as a tool in this field of exploration. As a result, the Coimbra Method was produced in 2009 as a standardized process for rectifying these common concerns. After the Coimbra Method was revised in 2015, this paper independently tested both the original and revised Coimbra Methods using archaeological and contemporary skeletal populations. These tests compared rates of intra-observer and inter-observer error using Cohen's Kappa, as well as percentage of agreement on the fibrocartilaginous attachment sites of the left and right upper limbs. Results using Cohen's Kappa showed that intra-observer error was substantial but inter-observer error was only moderate. Predictably, intra-observer percentage of agreement vastly improved from 75% to 89% with greater familiarity of the method. Ultimately, inter-observer percentage of agreement fell short from the minimum standard of 80% with an average of 75.2%. A high inter-observer agreement is critical if the Coimbra Method is to be used as the universal standard for any type of enteseal change research. As such, the inter-observer error rates from this study indicate that more revisions are needed before either of the Coimbra Methods can be recommended as a standard. However, the significant potential for this method in understanding past activities would make additional revisions undeniably worthwhile.

### Diet and health in 18<sup>th</sup> to 20<sup>th</sup> century Copenhagen

MARIE LOUISE S. JØRKOV<sup>1</sup> and DARREN R. GRÖCKE<sup>2</sup>

<sup>1</sup>Laboratory of Biological Anthropology, University of Copenhagen, Institute of Forensic Medicine, <sup>2</sup>Department of Earth Sciences, University of Durham

Our historical knowledge of diet in 18<sup>th</sup> to early 20<sup>th</sup> century is still not fully understood, but combining the historical records with the physical evidence from skeletal remains provides a powerful link between the discursive knowledge and individual life histories.

The recent excavations of 18<sup>th</sup> to 20<sup>th</sup> century burials in Copenhagen have provided a unique opportunity to study diet and the impact on health among socially distinct population groups

using stable isotope analysis of bone collagen and hair keratin.

There was very little skeletal evidence of specific infectious diseases despite of the time period (the Industrial period) being known for its high prevalence of e.g. syphilis and tuberculosis. However, metabolic diseases such as vitamin D and C- deficiencies were observed, especially among subadults. The isotope results of the subadults indicated that non-breastmilk foods were introduced within the first six months of life and that exclusive breastfeeding during the first year of life was less common. There was no statistical evidence to support the association between diet and pathological chronic conditions observed among the adults. However, bone-hair analysis indicated change in nutritional intake or change in health status months prior to death. Furthermore, significant differences were found in collagen  $\delta^{15}\text{N}$  values between males and female and between different socio-economic status with low social individuals consuming less protein rich diets than the middle and high class individuals.

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### The monastic mosaic at Mount Nebo, Jordan

MARGARET A. JUDD<sup>1</sup>, LESLEY A. GREGORICKA<sup>2</sup> and DEBRA FORAN<sup>3</sup>

<sup>1</sup>Anthropology, University of Pittsburgh, <sup>2</sup>Sociology, Anthropology, & Social Work, University of South Alabama, <sup>3</sup>Archaeology and Classical Studies, Wilfrid Laurier University

Mount Nebo, a Byzantine Christian monastery (AD491-640), purportedly the burial place of the prophet Moses, was and remains a popular pilgrimage destination. It is proposed that foreign monastics were also attracted here, but the communal funerary interment conceals these ethnic origins here and elsewhere. We use multiple lines of inquiry to extract evidence for a cosmopolitan monastic mosaic. Commingled skeletal remains from at least 83 adults from 2 east crypt chambers (EN and ES) were available for analysis. Adult membership was restricted to males of all ages.

Radiogenic strontium and stable oxygen/carbon isotope analysis from the enamel of 15 individuals was performed. The sampled members (n=4) of the EN crypt exhibited local signatures, while the ES crypt (n=11) contained 4 potential non-local migrants. For both crypts, few individuals (n=3) fell within the narrow confines of local  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios as defined by contemporaneous rodents (0.708148±0.000018, 2 $\sigma$ ), with the majority (n=8) clustering above this range (0.70823±0.00012, 1 $\sigma$ ). Overall ratio variability suggests that those

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interred here consumed water and foodstuffs from other geographic regions during childhood, fitting with the notion that these individuals were migrants to Mount Nebo.

The Mount Nebo regional monastic landscape incorporates various forms of monasticism including Egyptian asceticism, Palestinian coenobitism, and northern Syrian stylitism. Mosaic inscriptions provide further evidence of the network's ethnic diversity. Although most inscriptions were written in Greek, the etymology of the monastic names indicates both Semitic (local or Palestinian) and Greek origins.

Biological and archaeological evidence supports a monastic ethnic mosaic at Mount Nebo.

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### Comparison of fluctuating asymmetry level between normal and pathological specimens from modern Thai skeletal group

HYUNWOO JUNG<sup>1</sup>, EUN JIN WOO<sup>2</sup> and NOREEN VON CRAMON-TAUBADEL<sup>1</sup>

<sup>1</sup>Department of Anthropology, University at Buffalo, SUNY, Buffalo, NY, USA, <sup>2</sup>Division in Anatomy & Developmental Biology, Department of Oral Biology, BK21 PLUS Project, Yonsei University College of Dentistry, Seoul, Korea

The purpose of this study was to compare fluctuating asymmetry (FA) between normal and pathological cranial specimens. It was postulated that pathological specimens would have significantly higher FA scores than normal ones in the cranial region affected by the developmental disorder. For this study, a modern Thai skeletal group from Chulalongkorn University was analyzed using geometric morphometrics. 92 cranial landmarks were digitized using a MicroScribe G2X. Normal specimens comprised 66 adults (33 males and 33 females) and 8 sub-adults. Specimens with pathologies included two adults with abnormal upper palates, two sub-adults with craniosynostosis, and one sub-adult with natal absence of nasal bones. Procrustes analysis was conducted on the face, chondrocranium, and vault using Morpho J, and resultant FA scores were compared using Mann-Whitney U tests.

One adult specimen with an abnormal palate had highest FA in the chondrocranium, which does not include palatal bones, while the other abnormal adult did not have higher FA than normal specimens. In sub-adults, the specimen with sagittal craniosynostosis had higher FA than normal in the face but not the vault. Moreover, the specimen with missing nasal bones had higher FA than normal in both the chondrocranium and the vault, but not in the face. Only the specimen with coronal craniosynostosis had higher FA than the normal sample in all three cranial regions. In conclusion, the results of this study did not

support the hypothesis as higher FA scores of pathological specimens were not limited to the specific cranial region with developmental disorder.

*This study was supported by Professor Hee Jin Kim of the Division in Anatomy & Developmental Biology, Department of Oral Biology, Yonsei University College of Dentistry, Seoul, Korea*

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### Biological and cultural evidence for social maturation at Point Hope, Alaska: Integrating data from archaeological mortuary practices and human skeletal biology

LAURYN JUSTICE and DANIEL H. TEMPLE

Department of Sociology and Anthropology, George Mason University

This study explores social age in a sample of hunter-gatherers from Point Hope, Alaska using dental estimates of age-at-death and archaeological mortuary practices. Constructions of age based on biological milestones are not always applicable cross-culturally as maturation is also a cultural event. However, the ontology of identities within hunter-gatherers represents a neglected area of bioarchaeological research. Radiographs were taken of 70 mandibles associated with the Ipiutak (700-1200 BP) and Tigara (AD 1300-1700) cultural groups. Ages were estimated based on tooth formation. Data regarding grave goods, body positioning, and spatial orientation were interpolated from the original site report. In both cultures, subadults in the 0.0 to 2.0 year cohort are buried face down, without grave goods. In the 2.1 to 4.9 year cohort, subadults are buried with animal implements such as walrus tusks. In the 5.0 to 12.0 year cohort subadults are buried with adults and spatially positioned to the west. In some instances, these individuals are placed between the legs of adult males or buried in the arms of adult females, and the burial is overlain with grave goods. Funerary treatment consistent with adulthood begins at 15.0 years in both groups. These findings indicate similarity in social development between the Ipiutak and Tigara people, though stylistic variations in grave goods suggest transformations in the symbolic nature of these implements. This study demonstrates the value of integrating the archaeological mortuary record with biological data to enhance perspectives on the development of social boundaries associated with biological age in past communities.

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### 3D Modeling of Skeletal Remains Using Agisoft Photoscan: Best practices for Field Data Collection

JESSICA E. KAISER<sup>1</sup> and AYMAN M. DAMARANY<sup>2,3</sup>

<sup>1</sup>Department of Near Eastern Studies, University of California Berkeley, <sup>2</sup>Institute of African Studies and

Research, Cairo University, <sup>3</sup>Luxor Office, American Research Center Egypt (ARCE)

Three-dimensional modeling of osteological specimens has become an increasingly common part of the bioarchaeological toolkit, and has several advantages. First and foremost, working from a model allows for the study of fragile remains without risking damage to the physical specimen from repeated handling. Second, having access to accurate replicas may facilitate year-round research for bioarchaeologists working on seasonal projects where material cannot be removed from the field lab. In recent years, the price of 3D scanners has also decreased significantly. Even so, a cost of several thousand dollars can still be prohibitively expensive for smaller projects. In addition, even a portable 3D scanner may be difficult to clear through customs in certain countries. For these reasons, the technique of close-range photogrammetry (CRP) shows significant promise. CRP requires no specialized equipment, other than relatively inexpensive software (here Agisoft Photoscan), a set of scales, and a consumer-grade camera. A reported accuracy of +/- 1/10 mm is obtainable under ideal conditions. However, both lighting conditions and computer processing power may be less than ideal in a field setting. To assess best practices in data capturing in the field, we conducted a series of tests comparing models built from photos obtained under different lighting conditions, with different scale bars, and generated with different levels of resolution. Accuracy of the models was then evaluated using the open-source software CloudCompare. The results suggests that even relatively low resolution 3D models can be accurate enough to allow for osteometric data collection.

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### What SLACS might lack: Teaching Biological Anthropology and ethics at a small liberal arts college

ANN M. KAKALIOURAS

Anthropology, Whittier College

Few budding biological anthropologists imagine they will spend their careers at liberal arts or community colleges. While graduate school typically confers both academic community and the resources of research universities, small liberal arts colleges may lack institutional support for the building and maintenance of strong programs in Anthropology. Oftentimes the college will only support one position in biological anthropology, if any at all. Furthermore, the general education and service demands of a small college can overwhelm an academic's ability to focus on their research program. Ten years of teaching and leadership experience at a small, tuition-driven, "majority-minority" liberal arts college has taught me to be creative and flexible as I endeavor to both do my own work, and train students for future careers in biological anthropology. Being a lone

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biological anthropologist offers numerous opportunities to educate colleagues about the field. Sending students to the field and lab schools of larger universities builds their skills and exposes them to the larger academic world. Crucially, disciplinary divisions between sociocultural and biological anthropology may be less pronounced, offering students a wide range of perspectives in a respectful academic environment. Lastly, the collaborative integration of ethics training in the curriculum prepares both majors and non-majors for work in diverse communities.

### Differentiating Dental Wear Patterns: A Dental Microwear Study on the Philistine Population from Ashkelon

RACHEL E. KALISHER

Anthropology, New York University

In the summer of 2016, the Leon Levy Expedition to Ashkelon announced the discovery of a Philistine cemetery which contained the skeletal remains of approximately 215 individuals. While bioarchaeological research on the site is currently underway to examine Philistine health and genetic relationships, dental microwear analyses also provide complementary information about these notorious "sea peoples", who purportedly migrated from the Aegean to the southern Levantine coast in the early Iron Age. Thus, a dental microwear study was carried out to discern between social and dietary behavioral wear. The Philistine teeth recovered from Ashkelon display a variety of macroscopic dental wear patterns, including parabolic wear, specialized cording marks, "pipe" stem holes and toothpick marks. Observations of 40 Philistine individuals were taken as part of this study, which includes dental impressions from a combined total of 29 adults (11 males, 7 females, 9 indeterminate), 2 subadults and photographs from an additional 11 individuals that could not be sampled. For control, individuals exhibiting little wear were also cast. A profilometer attachment to a light microscope was used to analyze wear. All teeth were initially analyzed under 10X magnification for surface roughness. In cases of apparent non-dietary dental wear, higher magnification (<50X) was utilized to create area-specific models of the pattern. The results of this study demonstrate that attrition from dietary wear can be differentiated from wear attributed to social behaviors at Ashkelon. The utility of dental microwear analysis allows for a new understanding of the cultural practices of the Ashkelon Philistines.

### Diana monkeys (*Cercopithecus diana*) experience fewer mechanical challenges during periods of low fruit availability

ERIN E. KANE<sup>1</sup>, ADAM VAN CASTEREN<sup>2</sup>, M. ALEXANDRA WILKINS<sup>1</sup>, JORDAN N. TRAFF<sup>3</sup>,

SUSAN E. LAD<sup>3</sup>, DAVID J. DAEGLING<sup>3</sup> and W. SCOTT MCGRAW<sup>1</sup>

<sup>1</sup>Department Anthropology, Ohio State University,

<sup>2</sup>Max Planck Institute for Evolutionary Anthropology,

Max Planck Institute, <sup>3</sup>Department of Anthropology, University of Florida

The fallback food paradigm suggests that primates rely on low-quality but readily available resources when preferred foods are scarce. Foods consumed during these critical periods are often conceptualized as mechanically challenging. It has been hypothesized that the ability to process fallback resources during lean periods drives the evolution of dentognathic features. We address this question in a population of Diana monkeys (*Cercopithecus diana*) in Cote d'Ivoire's Tai National Park. Using data on ingestive behaviors and foods collected June 2013-March 2016, we test the hypothesis that Diana monkeys consume mechanically challenging foods requiring more intensive oral processing when preferred resources are scarce.

Diana monkey diets change significantly across the four seasons at Tai ( $\chi^2=23.307$ ,  $p<0.001$ ), incorporating more invertebrates and less fruit when fruit availability is lower. We find no relationship between dietary hardness (using Shore-A durometers) and fruit availability ( $R=-0.08$ ,  $p=0.81$ ). Diana monkeys use different oral processing behaviors when consuming different foods: fruits (23.56) and invertebrates (20.81) require significantly fewer masticatory cycles per ingestive action than do leaves (34.44) ( $F(2)=4.74$ ,  $p=0.009$ ). Fruits have higher rates of ingestion (1.8 fruits/minute) than invertebrates (0.8 invertebrates/minute).

These data provide little support for the hypothesis that Diana monkeys fall back on more challenging resources when fruit is scarce. Instead, they increase consumption of invertebrates, accompanied by lower rates of ingestion and mastication than utilized with fruit. These results, with our finding of no relationship between fruit hardness and food availability, suggest that Diana monkeys experience fewer mechanical challenges when preferred foods are scarce.

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### A multi methodological approach for human identification and reconstruction of cause and manner of death in forensic anthropology

FABIAN KANZ<sup>1</sup>, HERWIG BRANDTNER<sup>2</sup>, EVA MÜLLER<sup>2</sup>, FRANZ NEUHUBER<sup>2</sup>, STEFAN TANGL<sup>3</sup>, EDITH TUTSCH-BAUER<sup>2</sup>, OLIVER ANZBÖCK<sup>4</sup> and JAN CEMPER-KIESSLICH<sup>2</sup>

<sup>1</sup>Department of Forensic Medicine, Medical University of Vienna, <sup>2</sup>Interfaculty Department of Legal Medicine, University of Salzburg, <sup>3</sup>University Clinic of

Dentistry, Medical University of Vienna, <sup>4</sup>Anif Police Station, Salzburg Federal Police Headquarter

In the course of a speleological survey of the so called Horrer-duct (Untersberg, Salzburg, Austria) osseous remains were found together with historical skiing equipment approximately 250m below the entrance.

Comprehensive anthropological and histological investigations,  $\mu$ CT and DNA analyses were applied in order to establish a human ID as well as to shed light on the cause and manner of death and to estimate the PMI.

The absence of redundancy in recovered bone inventory, morphological features as well as multiple DNA tests allocate all found human remains to a single male individual. Age at death estimated by the epiphyseal fusions as well as tooth cementum annulation was narrowed down to 18-24y. Time since death could be approximated to the 1920s and 30s by specific features of the skiing equipment associated with the skeleton. Trauma analysis revealed multiple perimortal fractures. None of them potentially fatal, but the location and pattern of the injuries is consistent with blunt force injuries due to a downfall into the duct. No signs of bone healing were detected, neither by  $\mu$ CT evaluation nor by histological cross-sections of the fracture area at the medial end of the right clavicle.

Biological profile together with the estimated time since death led to the well founded assumption that the remains belonged to Karl Robert Kammerer, aged 21y when went missing during a skiing tour on March 21st 1929.

Final DNA-Identification by to two still living half-siblings was achieved, but temporarily obstructed by inconsistencies between the family record and biological kinship.

### Lucy's Knee: Evidence of a High-energy Dislocative Compressive Epiphyseal Fracture

JOHN KAPPELMAN<sup>1,2</sup>, RICHARD A. KETCHAM<sup>2</sup>, STEPHEN PEARCE<sup>3</sup>, LAWRENCE TODD<sup>1</sup>, WILEY AKINS<sup>4</sup>, MULUGETA FESEHA<sup>5</sup>, SISSI J. MATTOX<sup>1</sup> and ADRIENNE WITZEL<sup>1</sup>

<sup>1</sup>Anthropology, Univ Texas, <sup>2</sup>Geological Sciences,

Univ Texas, <sup>3</sup>Austin Bone and Joint Clinic,

Austin, TX, <sup>4</sup>Radio-Television-Film, Univ Texas,

<sup>5</sup>Paleoanthropology and Paleoenvironment Program, Addis Ababa University

A.L. 288-1, "Lucy", is a young adult female of *Australopithecus afarensis* discovered at Hadar, Ethiopia. She is dated to 3.18 million years in age and is represented by much of her skeleton including a nearly complete left femur and a partial right tibia. The knee of *Aus. afarensis*, especially as seen in specimen A.L. 129-1a,b, has proven to be very informative about the mode of bipedal terrestrial locomotion in this species. In contrast to A.L. 129-1a (right distal femur), the

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distal portion of Lucy's left femur is "...markedly crushed" (Johanson et al., 1982:426). We studied this damage using casts of the distal femur in its discovery state along with high resolution CT scans of the original fossil in its reconstructed state, and digitally segmented the fragments of the reconstructed regions to recreate the discovery condition. Our study shows that both condyles were shattered, the distal epiphysis was dislocated and compressively driven so deeply into the distal shaft that the superior extent of the patellar surface is not visible, and the lateral condyle was sheared superolaterally along the lateral edge of the distal shaft. We use the program Maya to produce a 3D animation that recreates the injury. Various alternative scenarios that might have been produced the compressive fracture are investigated, and we conclude that an impact following a fall from considerable height was most likely responsible for this high-energy injury.

*The University of Texas High-Resolution X-ray CT Facility was supported by U.S. National Science Foundation grants EAR-0646848, EAR-0948842, and EAR-1258878.*

### Odontometric Sex Assessment at the Early Bronze Age site of Ostojištevo (Serbia)

AMY N. KARABOWICZ and KATHERINE M. POMPEANI

Department of Anthropology, University of Pittsburgh

The Early Bronze Age (EBA; ca. 2000-1500 BCE) Maros mortuary site of Ostojištevo is located in northeast Serbia and provides evidence for the existence of gender-based social stratification in some areas of the Carpathian Basin during the EBA. Compared to other EBA Maros cemeteries, Ostojištevo is unique for including a large number of subadults (birth to 18 years-at-death), who comprise at least 47% of 289 excavated individuals. Gender in EBA Maros cemeteries was marked primarily through body orientation, with adult males typically buried with their heads oriented north or east and adult females oriented south or west. Previous analyses of subadult demography and health from EBA Maros cemeteries have used burial orientation as a proxy for biological sex.

This study applies odontometric methods to estimate biological sex from buccolingual and mesiodistal measurements of the permanent dentition of 112 individuals from Ostojištevo. Adults with sex determined via cranial and/or pelvic criteria were used to develop population-specific discriminant function formulae. These formulae were applied to estimate sex in indeterminate adults (n=12) and subadult (n=34) individuals. Although adults displayed minimal sexual dimorphism in dentition overall, measurements of the second incisor, canine, and first molar exhibit useful dimorphism. Results suggest that odontometric analysis offers a

valuable means of assessing biological sex in prehistoric Eastern European individuals, especially when osteological criteria are uncertain or unavailable. Furthermore, this approach highlights the problems of inferring biological sex of adults and subadults on the basis of gendered mortuary treatment.

### Dolichocephaly and occipital hemi-bun development in extant humans

MIRANDA E. KARBAN

Biology, Illinois College, Jacksonville, IL

Though the features' homology remains disputed, Neandertal occipital buns and anatomically modern human "hemi-buns" share many morphological similarities, including pronounced occipital squama convexity, paralambdaoid flattening, and endocranial occipital bone curvature. Some authors posit that the occipital bun/hemi-bun develops in response to a narrow or flexed basicranium, a narrow face, or a dolichocephalic (long and narrow) cranial vault. This study assesses these developmental hypotheses in a longitudinal sample of European-derived extant humans.

Frontal and lateral cephalograms from 26 subjects (16 males, 10 females) were each measured at three age points, spanning from 3.0 to 20.4 years. These subjects represented the ends of the range of variation in adult midsagittal occipital squama convexity, including 16 subjects (9 males, 7 females) with defined hemi-buns and 10 subjects (7 males, 3 females) with complete absence of hemi-bun morphology. Each age point was digitized with a total of 16 landmarks and 153 sliding semi-landmarks. Two-block partial least squares analysis and permutation procedure were conducted to assess patterns of craniofacial covariation.

In both sexes, defined hemi-buns were found to covary significantly with an elongated and low midsagittal neurocranial vault, thereby partially supporting the dolichocephaly hypothesis. Other aspects of craniofacial morphology, including cranial/basicranial breadth, midcoronal vault shape, facial dimensions, and basicranial angle, were not found to covary significantly with hemi-bun morphology at any of the sampled age points. These results suggest that the hemi-bun is not a discrete trait, but instead develops in association with a distinct pattern of neurocranial elongation.

### Dietary Reconstruction of Winnebago Phase Oneota: A Study of Dental Pathology

JORDAN KARSTEN, TABITHA DORSHORST, KAYLA KUBEHL and LAUREN SCHEIDER

Anthropology, University of Wisconsin Oshkosh

The Late Prehistoric Oneota are believed to have relied upon a subsistence system that was centered on intensive maize agriculture. Current knowledge regarding the diet of the Oneota is based primarily on studies of faunal and paleobotanical remains. However, very few studies have utilized Oneota human remains in their attempts to reconstruct their paleodiet. To improve our understanding of Oneota diet, 979 teeth belonging to 137 individuals excavated from Oneota sites around Lake Winnebago in Central Wisconsin, were examined in regards to dental pathology. Following standard methods, data was collected on dental caries, dental abscessing, antemortem tooth loss, and dental wear. Overall, the Winnebago Phase Oneota were found to have a dental caries rate of 8.07% when all teeth were considered. Furthermore, 12.07% of observable alveoli were observed to have been remodeled following antemortem tooth loss. Wear rates were generally high, and abscessing was rare. The complete dental picture suggests that the Oneota were likely consuming a diet rich in carbohydrates, most likely centered on maize.

### Palaeopathological Indicators of Mounted Pastoralism during the Mongolian Bronze Age

SARAH K. KARSTENS<sup>1</sup>, JUDITH LITTLETON<sup>1</sup>, BRUNO FROHLICH<sup>2</sup>, TSEND AMGALUNTUGS<sup>3</sup> and PEARLSTEIN KRISTEN<sup>2</sup>

<sup>1</sup>Anthropology, University of Auckland, <sup>2</sup>Anthropology, National Museum of Natural History, Smithsonian Institution, <sup>3</sup>Institute of Archaeology, Mongolian Academy of Sciences

The context and timing of the adoption of mounted or equestrian pastoralism is an important factor in understanding the social and economic changes that took place during the Mongolian Bronze Age. Archaeological evidence suggests that the practice may have spread into Mongolia from southern Siberia around the Middle Bronze Age (c.3500BP), however its introduction is still little understood. Palaeopathological analysis of human remains provides an opportunity to further study the adoption of mounted pastoralism in Mongolia, as habitual horse riding results in identifiable patterns of trauma and degenerative changes in the human skeleton. This study presents the results of an analysis of 25 individuals dated from 2700BP to 3500BP, excavated from the Hovsgol aimag in northern Mongolia. Rates of Schmorl's nodes and patterns of degenerative joint changes are consistent with results seen in clinical studies of modern equestrian athletes. Schmorl's nodes were recorded in 46% of assessable individuals (n=13), often on multiple vertebrae (average number of vertebrae affected=5.6). Degenerative changes were most commonly recorded for the acromio-clavicular surfaces, glenoid and vertebral apophyseal joints suggesting disproportionate loading of the

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shoulders. While these factors can also be associated with heavy manual labour, the presence of horse burials in the region coupled with these patterns of pathology indicate that during the Mid to Late Bronze Age people in this region were most likely reliant on horses for transportation.

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### Integration between the cranium and mandible in recent humans

DAVID C. KATZ, MARK N. GROTE and TIMOTHY D. WEAVER

Department of Anthropology, UC Davis

Covariance between traits can provide evidence of past selection or present environmental or behavioral influences, and may also be used to predict correlated responses to such pressures. Here, we quantify integration between the human cranium and mandible in order to assess the extent to which aspects of masticatory morphology vary together (1) within groups, and (2) between subsistence categories across the agricultural transition. We also test the hypothesis that less biomechanically demanding agricultural diets resulted in weaker masticatory complex integration in farming populations relative to hunter-gatherers.

The observations are three-dimensional landmarks recorded on a global sample of human crania and mandibles (337 individuals; 24 populations). All specimens are adults from pre-industrial cultures. Each cranium is paired with a mandible from the same individual. Cranio-mandibular covariance was estimated by fitting a quantitative genetics mixed model for highly multivariate data to the observations. The primary axis of within-group covariance is one along which the lengths of the cranial and mandibular tooth rows decrease as the distances from tooth rows to temporomandibular joint increase. Coordinated shifts in cranial and mandibular morphology across the agricultural transition are consistent with a hypothesis of reduced masticatory demands in farming populations. The results do not support the argument, made elsewhere, that aspects of *Homo sapiens* facial morphology reflect selection for the ability to generate high (or highly efficient) bite forces when chewing.

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### How to tell people who are from a place and people who are not from that place by how they are put in the ground after death and from things in their teeth

M. ANNE. KATZENBERG and ADRIANNE M. OFFENBECKER

Anthropology and Archaeology, University of Calgary

Paquimé, a large prehistoric site in northern Chihuahua, Mexico, was an important regional hub that features cultural characteristics typical of both Mesoamerica and the U.S. Southwest. Although foreign objects and iconography are clearly indicative of ties with outside groups, the nature and extent of Paquimé's relationship to neighboring regions is unclear. More specifically, was there a significant immigrant presence at the site and if so, where did these individuals fit within the emerging social hierarchy? Carefully documented mortuary practices indicate that some individuals were ceremoniously buried while others appeared as disarticulated or poorly articulated burials with no accompanying cultural remains. Strontium isotope analyses of tooth enamel from early and late forming teeth from the same individuals was carried out to determine whether individuals were born locally or non-locally. Isotope data were then compared to mortuary practices. Results indicate that 23% of the 69 individuals from the Medio period were not local to the site, based on strontium isotope ratios. While local and non-local individuals were found in most burial units, only local individuals were found in the most elaborate tombs. These results support the identification of Paquimé as a regional center with both local and non-local individuals, and further provide evidence that at least some local individuals enjoyed higher status.

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*Permission for study: INAH, Mexico and the Centro Cultural Paquimé, Mauricio Salgado, Director.*

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### Integrating Major Original Research Projects into Undergraduate-level Courses

LAURIE KAUFFMAN

Biology, Oklahoma City University

Soft-skills such as written and oral communication and critical thinking are highly valued by employers of recent college graduates. Educational research shows that students can gain these skills by participating in inquiry-based learning and/or undergraduate research. In addition, students involved in research are more likely to report satisfaction with their college experience, and are more likely to be retained and to graduate on schedule.

Here, I describe how I integrated a major student-generated research project into an upper level Animal Behavior course. Students spent the entire semester creating and carrying out a research project on animal behavior. This included steps such as generating questions and hypotheses, choosing appropriate methods, writing a research proposal and IACUC application, collecting and analyzing data, and finally presenting their results in the form of a poster. I explain how I integrated smaller assignments throughout the course and lab to prepare

students to successfully complete their projects. Finally, I share the results of the projects, and how students responded in their course evaluations.

I argue that upper level students of any discipline are capable of conducting original research as long as they are well-supported. Research projects such as those presented here can fully involve students in the process of science and can help students immediately apply the content they are learning in their courses.

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### Adult and early childhood diet of early medieval untypical population group of Central Europe (10<sup>th</sup> century AD, Czech Republic) in relation to the health status

SYLVA KAUPOVA<sup>1</sup>, PETR VELEMINSKY<sup>1</sup>, PETRA STRANSKA<sup>2</sup> and KATERINA TOMKOVA<sup>2</sup>

<sup>1</sup>Dept. of Anthropology, National Museum, Prague,

<sup>2</sup>Institute of Archaeology, Czech Academy of Sciences vvi.

The aim of this study was to uncover the causes of the distinct characteristics of the 10<sup>th</sup> population group from Prague – the Milady Horákové cemetery. The demographic structure of this sample (N=84) was atypical for its majority of subadults and almost absence of males. Also, a high incidence of skeletal pathologies and dental anomalies was observed. The total area of the cemetery was excavated. According to the grave goods found, it was probably the cemetery of the middle class.

Adult diet was explored through the stable carbon and nitrogen isotope analysis of bone collagen. Moreover, diet and health during infancy and early childhood was explored based on the stable isotope analysis of dentin serial sections of M1 and by the recently developed approach of the micro-CT analysis of linear enamel hypoplasia (LEH).

The stable isotope analysis revealed that the diet of this sample differed from the rest of the early medieval population of Prague by a lower proportion of both animal protein and C<sub>4</sub> plants (mean  $\delta^{13}\text{C} = -18.95 \pm 0.7$ ; mean  $\delta^{15}\text{N} = 9.1 \pm 0.8$ ).

The analysis of childhood diet revealed the introduction of supplementary food at or before 6 months of age and the gradual cessation of breastfeeding, completed around 3 years on average with substantial variability. The incidence and timing of LEH is discussed in relation to the isotopic dietary signal.

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### Are there any African Platyrrhines?

RICHARD F. KAY<sup>1,2</sup> and BLYTHE A. WILLIAMS<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Division of Earth and Ocean Sciences, Duke University

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New World monkeys (Platyrrhini) arrived in South America in the middle Cenozoic. A recent fossil discovery in Amazonian Peru reported by Bond and colleagues may be the oldest platyrrhine primate (*Perupithecus*) at 36-Ma, perhaps 10 million years older than the hitherto oldest known platyrrhine, the late Oligocene *Branisella*. If the age is corroborated, the newly extended antiquity of Platyrrhini is consistent with molecular clock phylogenies that place the branch time between Old and New World monkeys in the Middle Eocene. The new fossils also are concordant with 37-Ma African fossils that belong to catarrhine anthropoids, establishing that a catarrhine-platyrrhine split had already occurred by late Middle Eocene.

The discovery of *Perupithecus* rekindles the debate about whether any known African Eocene-Oligocene anthropoid clades (Afrotarsiidae, Parapithecoidea, or Oligopithecidae) is sister to platyrrhines. To examine whether *Perupithecus* can be linked with any of these clades, we undertook an expanded phylogenetic parsimony analysis of living and fossil New World monkeys and African Eocene-Oligocene anthropoids. We incorporated dental, cranial and postcranial anatomy and constrained our analyses with well-corroborated extant anthropoid phylogenies that are based on genomic data. With the caveat that there are considerable uncertainties in our analysis due to *Perupithecus* being known from just the type specimen, an upper molar and perhaps several lower molars, we do not find a phylogenetic link between Amazonian *Perupithecus* and any particular African clade. Although platyrrhines almost certainly rafted from Africa in the mid-Cenozoic, a sister-relationship with any known African clade is not yet established.

Support from NSF 1338694

### Cultural hybridity and Greek colonization: A case study of Himeria utilizing strontium isotope analysis

ADAM C. S. KAZMI<sup>1,2</sup>, LAURIE J. REITSEMA<sup>1</sup>, KATHERINE L. REINBERGER<sup>1</sup>, BRITNEY KYLE<sup>3</sup> and STEFANO VASSALLO<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of Georgia,

<sup>2</sup>Department of Classics, University of Georgia,

<sup>3</sup>Department of Anthropology, University of Northern Colorado,

<sup>4</sup>Regional Archaeological Superintendence of Palermo, Italy

Greek colonization of Sicily was a complex process which often resulted in the creation of a "hybrid" culture. This study utilized strontium isotope analysis of 18 individuals buried in the flexed (n=8) or supine (n=10) position in the western necropolis at Himeria (7<sup>th</sup>-5<sup>th</sup> c. BCE) to assess whether burial style reflects a person's geographic point of origin. Supine positions have been interpreted in Greek colonial contexts as being a Greek practice while flexed positions

have been interpreted as a local practice. We test the hypothesis that supine individuals are more likely to be non-local than flexed individuals using previously analyzed faunal strontium isotope ratios to establish a local bioavailable strontium range. Results of this study indicate that individuals buried in both styles fall largely into the local bioavailable strontium range (0.709114-0.708622). There were two individuals buried in flexed positions and three individuals buried in supine positions who displayed non-local strontium signatures. The differences in these data are not statistically significant, meaning there is no difference between flexed and supine burial positions in regards to an individual's local or non-local status. As most individuals analyzed fall within the local bioavailable strontium range of Himeria, their burial position must reflect some influence other than geographic origin. This indicates the possibility that Himerian individuals were buried in specific positions which reflected their chosen cultural or social identity in life.

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### Cranial Variation and Taxonomic Diversity among Late Miocene Hominoids from Yunnan, China

JAY KELLEY

Institute of Human Origins, Arizona State University, Department of Paleobiology, Smithsonian Institution

Large-bodied hominoids are known from three temporally and geographically proximate latest Miocene sites in Yunnan, China: Yuanmou (ca. 8-7 Ma), Lufeng (ca. 7-6 Ma) and Shuitangba (6.1 Ma). Yuanmou and Shuitangba preserve single, largely undistorted partial juvenile crania that are at roughly the same developmental stage, with M1's either nearing (Yuanmou) or already in occlusion (Shuitangba) and M2's still unerupted. Study of ontogenetic change in the crania of extant great apes reveals that, by the time the M1's are coming into occlusion, the characteristic adult morphological pattern has been established. Further change largely involves the deepening and relative increase in size and robusticity of the splanchnocranium, all related to the eruption of the permanent dentition and associated hypertrophy of the masticatory musculature. At initial M1 occlusion, juvenile ape crania are, in many respects, diminutive versions of adult crania and can be validly used for evaluating taxonomy.

The juvenile crania from Yuanmou and Shuitangba differ markedly in orbital shape, frontation and projection, supraorbital costae development, projection of the nasals and rhinion, zygomatic shape, and orientation of the malar region. A juvenile frontal from Lufeng bears close resemblance to that of the Shuitangba cranium. Based on variation in extant primates, the nature

and magnitude of differences between the Yuanmou and Shuitangba (and perhaps Lufeng) crania warrant separation at the generic level. This level of morphological diversity is mirrored in the taxonomic diversity of other primates from these sites, which may relate to the geophysical setting of southern China at this time.

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### Revealing variation in social integration: Diet and migration at the ceremonial site of La Marcha, Peru in the southern Nasca region (1-1000 BCE)

CORINA M. KELLNER<sup>1</sup>, VERITY WHALEN<sup>2</sup> and ALEJANDRA FIGUEROA FLORES<sup>3</sup>

<sup>1</sup>Anthropology, Northern Arizona University,

<sup>2</sup>Anthropology, Wake Forest University, <sup>3</sup>Analyst, Flagstaff Medical Center

The Nasca of southern Peru were well integrated into the social, political, and economic process affecting the Andes during the first millennium CE. Recent bioarchaeological studies, however, reveal previously hidden variation in dietary patterns and migration rates between the valleys of the Nasca region. La Marcha, a multicomponent site near the large Middle Horizon (750 CE) polity of Huaca del Loro, may have been an important burial and ceremonial site for the people of the Las Trancas Valley, perhaps rivaling Cahuachi to the north. Using bioarchaeological methods and biogeochemical techniques, we shed light on the nature of social integration of the Las Trancas people during times of environmental and political challenges. Overall, stable isotope results from carbon and nitrogen show that diet was maize based but included slightly more C3 foods than other Nasca people. Strontium isotope values suggest the low migration rates into this valley, with only one individual from this site exhibiting strontium values indicative of migration. Bone and teeth recovered from one young woman suffering from an active tooth abscess at the time of her death suggests maize weaning foods and an adult mixed C3/C4 diet, while her hair suggests high stress and dietary values consistent with illness before death. In contrast to likely elites and migrants buried at Cahuachi, La Marcha may have been a local insular ceremonial site for the people of Las Trancas.

*Northern Arizona University Study Abroad program was instrumental in funding the investigation of La Marcha.*

### The Effect of Leprotic Infection on the Risk of Death in Medieval Rural Denmark

KIRSTEN S. KELMELIS, MICHAEL H. PRICE and JAMES W. WOOD

Anthropology, Pennsylvania State University

Paleopathological studies of leprosy in skeletal collections reveal that many individuals suffered from this highly stigmatized disease during the

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middle ages. Previous research on leprotic lesions has focused on urban populations, but leprotic infection was not confined to urban populations. This study examines the risk of death associated with leprotic infection in individuals from the Danish rural cemetery of Øm Kloster (1172-1561 A.D.). The sample consists of 311 adult individuals from the Øm Kloster skeletal collection housed at the Department of Anthropology of the University of Southern Denmark (ADBOU). The analysis was run using a multistate model estimating mortality and morbidity for paleodemography. To assess the risk of mortality, the distributions of age at death and lesion status were considered to provide information on transitions from one state of health to another before death, and to estimate the force of mortality associated with the presence of leprotic lesions. The mortality hazard of lesioned individuals exceeded that of non-lesioned individuals by a factor of 6.26 ( $p$ -value = 0.0014). These results are important for improving our understanding of population health dynamics with regard to long lived chronic infectious diseases, and the methods here can potentially be informatively applied to larger analyses of community health and well-being from skeletal collections.

### Body Size Estimation for the Shanghuang Petrosal

ADDISON D. KEMP<sup>1</sup>, E. CHRISTOPHER KIRK<sup>1,2</sup> and K. CHRISTOPHER BEARD<sup>3,4</sup>

<sup>1</sup>Anthropology, University of Texas at Austin,

<sup>2</sup>Jackson School of Geosciences Vertebrate Paleontology Lab, University of Texas at Austin,

<sup>3</sup>Ecology and Evolutionary Biology, University of Kansas, <sup>4</sup>Biodiversity Institute, University of Kansas

The taxonomic affinities of a primate petrosal from the Eocene of Shanghuang, China have been debated for two decades. The petrosal was recovered from fissure D, which also produced dental remains of adapoids, an omomyoid, and *Eosimias*. The petrosal was attributed to *Eosimias* because of its small size. The omomyoid dentition found in fissure D belongs to *Macrotarsius* (~1,600g) and the adapoid dentition belongs to *Adapoides* (~200-400g). Alternate attributions of this petrosal have significant implications for our understanding of early primate evolution. Phylogenetic analyses in which the petrosal is not considered *Eosimias* support a tarsier-anthropoid clade to the exclusion of omomyoids. If the petrosal is included as *Eosimias*, phylogenetic analyses suggest that the otic similarities between tarsiers and anthropoids evolved convergently.

Here we use a comparative sample of computed tomography scans of primate petrosals ( $n=24$ ) to provide the first body size reconstruction for the Shanghuang petrosal. Body mass for the Shanghuang petrosal was estimated based on cochlear labyrinth volume. Cochlear volume

explains 82% of variation in body mass across the primates sampled ( $p < 0.01$ ). Body mass for the Shanghuang petrosal specimen is estimated to be 34 grams (range 5-224g). This extremely small mass estimate confirms that the petrosal does not represent *Macrotarsius*. However, a body mass of 34g falls within the range of body sizes reconstructed from postcranial remains of both eosimiids (17-131g) and basal haplorhines from Shanghuang (12-353g). Estimated body mass for the Shanghuang petrosal is thus consistent with either basal haplorhine or eosimiid affinities.

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### Data standardization in anthropology: Curation and access

ASHLEY E. KENDELL<sup>1</sup> and NICOLE L. GESKE<sup>2</sup>

<sup>1</sup>Anthropology, University of Montana, <sup>2</sup>Anthropology, Michigan State University

In recent years, skeletal analysis and collection of data from human skeletal remains have been endowed with a sense of urgency following enactment of federal repatriation legislation. The field of physical anthropology was forward-thinking in developing *Standards for Data Collection from Human Skeletal Remains (Standards)* in an effort to minimize the loss of data and maximize comparability of data between institutions across the country.

Twenty-five years after the enactment of repatriation legislation, many institutions are collecting skeletal data according to *Standards*, however, problems still arise from differences in inter-agency data collection practices. Likewise, as a field, anthropology has not yet embraced the importance of data mining and code writing for the extraction of standardized archival data from relational databases. In order to increase the accessibility of digitized archival data, techniques drawn from computer science must be integrated into the standard anthropological curriculum.

The primary goal of this presentation is to outline the importance of not only intra-, but also inter-agency data collection methods, as well as to address the perceived difficulties of osteological database curation and access. This research also has fundamental importance to the field of bioarchaeology because it highlights the importance of expanding the standard anthropological curriculum to include courses pertaining to relational databases structure and design and data mining techniques. Until we increase the accessibility of our osteological data, *Standards* will never reach their full potential within the field of bioarchaeology.

### Class and Continuity in a Roman/Parthian Period cemetery at Tall Šā'āq āḩamad, Syria

JENNIFER G.L. KENNEDY<sup>1</sup> and D. ANDREW MERRIWETHER<sup>2</sup>

<sup>1</sup>Sociology, Anthropology and Social Work, Central Michigan University, <sup>2</sup>Anthropology Department, Binghamton University, SUNY

Genes do not determine daily social behavior, individual identity nor do they represent an actively manipulated object. They do however provide indirect evidence that allows one to add another layer of interpretation to the ambiguous material remains, much like that of isotopic signatures. The site of Tall Šā'āq āḩamad during the Roman/Parthian period (200 BCE - 300 CE) existed as a border settlement influenced by both Rome and Parthia. Whether the inhabitants considered themselves to be Roman or Parthian becomes irrelevant as they could "alternatively be seen as made up by people of both indigenous and colonial descent who have together created distinctly new communities" (van Dommelen 2005: 117). Viewing Tall Šā'āq āḩamad as a community that came into contact with both imperial powers, we can expect not only that material artifacts could appear with characteristics of both but also the very genes of its inhabitants could potentially reflect this social hybridity. In an effort to examine these ideas this study presents forty molecular profiles of individuals from the Roman/Parthian period at Tall Šā'āq āḩamad, Syria in conjunction with archaeological mortuary evidence to assess their cultural and biological characteristics. Results indicate a relatively homogenous population with little evidence of a recent influx of new alleles during the period under consideration despite the political disruption in the region. Calculated genetic distance between individuals buried in different burial forms however indicate a socio-economic distinction between classes that impacted the sociality of burial.

### A metric approach to assessing sex in the Erie County Poorhouse Collection

BRITTANY A. KENYON<sup>1</sup>, SARAH E. BAUMGARTEN<sup>2</sup> and JOYCE E. SIRIANNI<sup>1</sup>

<sup>1</sup>Anthropology, University at Buffalo - SUNY,

<sup>2</sup>Anthropology, Washington University in St. Louis

In 2012, construction at the University at Buffalo unearthed skeletal remains of individuals from the Erie County Poorhouse Cemetery (ECPC) and hospital. Subsequent demographic analysis determined that there were 207 adults: 97 males, 49 females, and 61 indeterminates.

Morphoscopic sex assessment of ECPC individuals is often inconclusive due to their high fragmentation. Baumgarten previously proposed a metric approach to estimating sex from fragmented innominates using 11 measurements, and six discriminate functions based on landmark

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absence. The purpose of the current study is to test Baumgarten's approach and subsequently estimate the sex of individuals from the ECPC.

This study utilizes a sample of 20 randomly selected, fragmented innominates of unknown sex from the ECPC and a control sample of 15 innominates of known sex, determined by DNA analysis. All six discriminate function equations were first tested on the 15 innominates of known sex. Within the control sample, the metric analysis correctly estimates sex at a rate of 87%. This high level of accuracy demonstrates the efficacy of applying this method to unknown individuals. Measurements were taken on 20 fragmented innominates and then entered into the appropriate discriminant function based on the landmark(s) present. Of the 20 innominates measured, 18 were estimated to be male and 2 were estimated to be female.

The positive results from the control sample suggest that the metric approach provides an improved method for estimating the sex of unknown remains. These results show that this method should be applied to the remaining 172 individuals from the ECPC.

### Maternal Environment and Craniofacial Growth: Geometric Morphometric Analysis of Mandibular Shape Changes Associated with *In Utero* Overexposure to Thyroxine in Mice

MATTHEW J. KESTERKE<sup>1</sup>, MARGARET A. JUDD<sup>2</sup>, MARK P. MOONEY<sup>2,3</sup>, MICHAEL I. SIEGEL<sup>2</sup>, JAMES CRAY<sup>4</sup>, MOHAMMED ELSALANTY<sup>5</sup>, R. NICOLE HOWIE<sup>4</sup> and SETH M. WEINBERG<sup>2,3</sup>

<sup>1</sup>Biomedical Sciences, Texas A&M University, <sup>2</sup>Anthropology, University of Pittsburgh, <sup>3</sup>Oral Biology, University of Pittsburgh, <sup>4</sup>Oral Health Sciences, Medical University of South Carolina, <sup>5</sup>Oral Biology, Augusta University

An estimated 3% of U.S. pregnancies are affected by maternal thyroid dysfunction, with between one and three of every 1,000 pregnancies being complicated by overactive maternal thyroid levels. Overactive maternal thyroid hormones are linked to neurological impairment and craniofacial development dysmorphogenesis, affecting both endochondral and intramembranous bone. Using a geometric morphometric approach, this study evaluates the role of *in utero* thyroxine overexposure on the growth of offspring mandibles in a sample of 241 mice. Principle component analysis (PCA) and canonical variate analysis (CVA) utilized 16 unilateral mandibular landmarks obtained from 3D microCT to assess shape changes between unexposed controls (n=63) and exposed mice (n=178). By evaluating shape changes in the mandible among three age groups (15, 20, and 25 days postnatal) and different dosage levels (low, medium, and high), this study found that excess maternal thyroxine alters offspring mandibular shape in both age- and

dosage-dependent manners. Group differences in overall shape were significant ( $p < 0.001$  for both PCA and CVA) and showed major changes in regions of the mandible associated with muscle attachment (coronoid process, gonial angle) and regions of growth largely governed by articulation with the cranial base (condyle) and occlusion (alveolus). These results complement recent studies demonstrating that maternal thyroxine levels can alter the cranial base and cranial vault of offspring, contributing to a better understanding of both normal and abnormal mandibular development the medical implications of craniofacial growth and development.

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### Skeletal Midshaft Diameters as Estimators of Age at Death in Subadults

MARISA T. KETCHUM and STEPHEN NAWROCKI  
Biology, University of Indianapolis

An estimate of age at death is an important component of the profile constructed for an unidentified decedent in forensic contexts, and it is also essential for understanding population structure in bioarchaeological contexts. Estimating subadult age, however, is often made more difficult by poor preservation; erosion can differentially damage the ends of long bones, and small tooth crowns can become lost or damaged, precluding the use of the two most effective estimators currently available. In these cases, the remains may only consist of long bone fragments with the thickest cortices. This study tests whether midshaft diameters of long bones can be used instead of lengths to estimate age at death in subadults. The six major long bones were measured for 62 individuals with known chronological ages (6 months prenatal to 18 years) drawn from the Maxwell Museum and Hamann-Todd collections. The Pearson correlations between length and diameter range from  $r=0.95$  to  $0.98$ , suggesting that diameters should be useful for estimating age. Correlations between bone lengths and known age at death in lunar months range from  $r=0.95$  to  $0.97$ ; correlations between midshaft diameters and age range from  $r=0.90$  to  $0.95$ , with higher values for the lower limbs. The relationship between diameter and age is slightly curvilinear, with a rapid increase in thickness through the first year of postnatal life and slower growth until the teen growth spurt is attained. A non-linear (power) regression formula using the best indicator (femur diameter) takes the form:  $\text{age} = 0.405(\text{diameter}^{1.8993})$  ( $r^2=0.965$ , inaccuracy = 18.2 months).

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### A Multi-Isotopic Approach to the Reconstruction of Prehistoric Mobility and Burial Patterns in the Iranian plateau during Bronze Age

FARNAZ KHATIBI JAFARI

Graduate school of frontier science, The university of Tokyo

Developing empirical evidence for individual mobility and immigration in the archaeological record remains difficult. Due to the indirect nature of much available data, the variation in residential backgrounds of individuals in skeletal populations is seldom explicitly characterized and the insights gained from bio-archaeological analyses are limited. Strontium isotope analysis of bone and tooth enamel from prehistoric human skeletons is an important new technique used to address questions regarding migration. Strontium isotopes serve as geochemical signatures that can be used to source a prehistoric skeleton to a geologic area, depending on how mobile the individual was during life. Analysis of the bones of small animals provides a robust measure of local strontium isotope ratios and a reliable, if conservative means for determining confidence limits for distinguishing migrants. Data from Iranian plateau Bronze Age archaeological burial sites are presented here in a discussion of variability in strontium isotope values from the well-preserved, well-contextualized skeletal population from different regions in Iran, focusing on Elamite Kingdom (2nd millennium BC) in the southern Khuzestan Province of Iran. The city studied called Kabnak that is an important political center, destroyed by the Mesopotamian political power. The Iranian results were compared to isotopic value with their neighbors in Mesopotamia and Indus valley.

Examples are provided using modern and prehistoric materials. A range of small animal, local plant and water sample for comparative purposes was incorporated.

### Eastern States Mental Hospital: Does the Presence of Heavy Metals as Evidenced by pXRF in the Bone and Teeth Indicate use of "Heroic Medicine" ?

PETER E. KILLORAN

Sociology, Criminology and Anthropology, University of Wisconsin Whitewater

The Eastern States Mental Hospital (ESH) opened in 1824 to care for the mentally ill for the State of Kentucky. It is the second oldest in the United States. The doctors from Transylvania University practiced Benjamin Rush's "heroic medicine" on the patients at ESH. Rush advocated large doses of calomel, an opium and mercury based medicine. Additionally other medicines laden with arsenic, lead and other heavy metals were common. In 2005 and 2011 during construction on the premises, human burials were disinterred.

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The graves date to 1839 and 1861. A total 186 individuals were recovered. Previous skeletal documentation of teeth and mandible suggested pathologies indicative the presence of mercury. Ninety-four individuals from Eastern States and 13 individuals from the nearby Horse Park Cemetery were examined. Teeth and bones were scanned using a portable XRF scanner. A total of 418 scans were taken. The following heavy metals were identified from the scans of Eastern States individuals: Arsenic, Lead, Chromium, Cadmium, Barium and Cesium. Lower amounts were observed for the Horse Park Cemetery. Examination of spectra for ESH showed the characteristic three spike curve of mercury. While the output for pXRF was not sensitive enough to unequivocally document the presence of mercury it provided a noninvasive path for investigation. Results from mass spectrometry and ICP spectrometry confirmed the presence of mercury.

Research was funded by a grant to Peter Killoran and Undergraduate Researchers Alyssa Fernandez and Amy Qualmann through the University of Wisconsin-Whitewater SURF grant program.

### Understanding population-specific age estimation using documented Asian skeletal samples

JIEUN KIM

Departments of Anthropology and Scientific Computing, Florida State University

Understanding aging patterns and rates of the adult skeleton is one of the most challenging tasks to skeletal biologists because senescence is easily influenced by both intrinsic (i.e., genetics) and extrinsic (i.e., nutrition, pathology, activities, etc.) factors. Among the myriad of different variables, ancestral affiliation has been suggested to play a highly impactful role in influencing age-related trait expressions, such that applying one method developed on a particular population is not relevant to another population. While there has been a strong emphasis on developing and using population-specific methods, what level of population-specificity one age estimation method should offer is relatively underexplored. The key to addressing this question lies in a holistic understanding of population history as well as systematic studies of subgroups within a continent.

This study investigates whether an aging method should be region-specific or continental-specific using 20th century Japanese (n= 183) and modern Thai (n=236) individuals from four documented skeletal collections. Four age estimation methods were applied to the Asian samples, including Transition Analysis (Boldsen et al. 2002), and three conventional methods (Suchey and Katz 1998, Lovejoy et al. 1985, Meindl and Lovejoy 1985). Final age estimates were obtained using multivariate ordered probit regression under Bayesian inference.

The results show that an age estimation model derived from a pooled-Asian sample performs superior to Japanese-/Thai-specific models. In addition, error and bias in age estimates induced by biased reference samples are greater than expected, and such error can be falsely interpreted due to between-population variation in skeletal aging.

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### *Australopithecus sediba* and the Origin of *Homo*: Questionable Evidence from the Cranium of the Juvenile Holotype MH 1

WILLIAM H. KIMBEL<sup>1,2</sup> and YOEL RAK<sup>1,3</sup>

<sup>1</sup>Institute of Human Origins, Arizona State University,

<sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Department of Anatomy and Anthropology, Sackler School of Medicine, Tel Aviv University

Malapa Hominid (MH) 1, an immature individual whose second permanent molars had recently reached occlusion at the time of death, is the holotype of *Australopithecus sediba*, a 2-myr-old South African taxon that has been hypothesized to link phylogenetically australopith-grade hominins to *Homo*. Given the existence of 2.8 myr-old fossils of the genus *Homo* in eastern Africa, this hypothesis implies a ghost lineage spanning at least 800 kyr. An alternative hypothesis posits a unique relationship between *A. sediba* and *A. africanus*, which predates the Malapa hominins in southern Africa and whose phylogenetic relationships remain ambiguous. The craniofacial morphology of MH 1 looms large in the framing of the two hypotheses, which we investigated in two ways. First, we investigated whether the craniofacial morphology of MH 1 was ontogenetically stable at death. Based on data from a late-growth series of chimpanzee, gorilla, and modern human crania, we found that key aspects of MH 1's resemblance to *Homo* are accounted for by its immaturity. Second, we studied MH 1 with an eye to identifying craniofacial synapomorphies shared with *A. africanus*. In this case, MH 1 shows unambiguous affinities in its zygomaticomaxillary and supraorbital morphology to crania from Sterkfontein Member 4, which we found to exhibit unusual derived morphology compared to *Homo* and other australopiths. We argue that MH 1 provides clear evidence that *A. sediba* was uniquely related to *A. africanus* and that the hypothesis of an extensive ghost lineage connecting *A. sediba* to the root of the *Homo* clade is unwarranted.

Travel funding provided by the Institute of Human Origins at Arizona State University.

### A 2D Geometric Morphometric Analysis of Cercopithecoid Mandibular Symphysis Outline Shape: Implications for Taxonomy and Systematics

CLARE M. KIMOCK

Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology, NYCEP

Mandibular symphysis morphology is often used in descriptions and diagnoses of fossil primate taxa. Variation in symphyseal outline shape has been extensively investigated in hominoids. However, high-resolution quantitative studies of variation in this character in cercopithecoids are lacking. This study tests the hypothesis that there are significant differences in cercopithecoid symphyseal outline shape at the subfamily and generic levels. Images of the mandibular symphysis of extant colobines and cercopithecines were generated from CT scans. Sliding semilandmarks were placed around the symphyseal outline. Landmark data were analyzed using generalized Procrustes analysis, principal component analysis, Procrustes ANOVA, discriminant function analysis, and leave-one-out cross validation. Results indicate that symphyseal outline shape discriminates extant cercopithecines and colobines well. Procrustes ANOVA tests indicated significant differences in symphyseal outline shape at the subfamily level ( $p = .001$ ). Eighty eight percent of specimens were classified correctly using the DFA results and 84% using leave-one-out cross validation. However, generic level differences are less clear. These findings suggest that symphyseal outline shape is a useful character for alpha taxonomy at the subfamily level but less so at the generic level, and that symphyseal morphology should be used in conjunction with other craniodental characters when diagnosing fossil cercopithecoid taxa. These results also highlight the importance of using high-resolution quantitative methods when comparing the morphology of fossil and extant cercopithecoids.

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### When to wean? The complex interaction between weaning behaviour, physiological stress and individual decision-making in the children of the Atacama Desert

CHARLOTTE L. KING<sup>1</sup>, SIÂN E. HALCROW<sup>1</sup>, ANDREW R. MILLARD<sup>2</sup>, DARREN R. GRÖCKE<sup>3</sup>, VIVIEN G. STANDEN<sup>4</sup> and BERNARDO T. ARRIAZA<sup>5</sup>

<sup>1</sup>Department of Anatomy, University of Otago,

<sup>2</sup>Department of Archaeology, Durham University,

<sup>3</sup>Department of Earth Sciences, Durham University,

<sup>4</sup>Departamento de Antropología, Universidad de Tarapacá, <sup>5</sup>Instituto de Alta Investigación, Universidad de Tarapacá

Weaning behaviour reflects a complex array of factors including cultural beliefs, maternal and

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infant health, disease prevalence and general food availability. Its study therefore has the potential to inform bioarchaeologists about numerous aspects of early-life experience in the past. In this study we present results from the first incremental isotopic study to be conducted in the northern Atacama Desert in Chile. This type of analysis has allowed us to reconstruct detailed individual life-histories, giving unprecedented insight into the weaning transition. Using deciduous dentition ( $n=30$ ) from the pre-agricultural (<3500BP), incipient agricultural (3500-1500BP) and fully agricultural (1500-400BP) periods we aim to tease apart the factors affecting weaning decision-making in this extremely harsh environment. We examine isotopic profiles of children, identifying patterns relating to both weaning and environmental stress. We show that, despite the presence of cultures with reported proscribed weaning behaviour, the decision of when to wean remained deeply individual. In almost all individuals analysed we find isotopic patterns indicative of physiological stress, probably reflecting the difficult reality of life in the desert. We highlight the interconnected nature of physiological stress and weaning decisions, and their potential impact on the children of the Atacama.

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### Correlates of fecal androgens in wild female white-faced capuchins (*Cebus capucinus imitator*)

GILLIAN KING-BAILEY and KATHARINE M. JACK  
Anthropology, Tulane University

Androgens are conventionally considered 'male' hormones, however they play a crucial role in regulating the female reproductive system. Few studies have compared female androgen levels across life stages, when animals have differing survival and reproductive strategies. Further, social factors may influence androgens. This study investigates mean fecal androgen levels in female *Cebus capucinus imitator* at Sector Santa Rosa, Área de Conservación Guanacaste, Costa Rica. We collected fecal samples from July to September 2015 from 24 individuals in three long-term study groups. Hormones were quantified and validated at the Laboratory for the Evolutionary Endocrinology of Primates at the University of Arizona using enzyme immunoassay. Based on age-class we found no significant difference between females (t-test,  $df = 23$ ,  $P > 0.05$ ). Based on reproductive state, we found no significant difference between adult females (ANOVA,  $df = 19$ ,  $P > 0.05$ ). Based on these findings we suggest that androgens play a more nuanced role in female reproductive biology than in males in our study species, though potentially no less important. There was no significant

correlation between androgens and rank (correlation,  $N = 19$ ,  $P > 0.05$ ). Our smallest study group (8 monkeys) exhibited significantly higher androgens than larger groups (19 and 26 monkeys) (correlation,  $N = 19$ ,  $P = 0.017$ ). We suggest between group competition functions to prime individuals in smaller groups for a fight or flight response. Future directions include increasing our sample size, both in number of samples and individuals, and examining and controlling for potential confounding variables.

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### Morphological Correlates of Locomotor Mode in the Volar Pads of Strepsirrhine Primates

AMANDA K. KINGSTON  
Department of Basic Medical Sciences, University of Arizona College of Medicine

Primates are unique among arboreal mammals in their exclusive use of friction grasps during arboreal locomotion. Mediolaterally compressed claws—used to interlock with substrates—are absent, and the ability to maintain a secure attachment during vertical and oblique locomotion is determined entirely by the integrity of the grasp. The frictional characteristics of the volar surfaces are influenced by the size and shape of the volar fat pads, however, it remains unclear how different pad morphologies are associated with various modes of locomotion. This study addresses this question through gross morphological evidence. The manual and pedal volar surfaces of 104 individuals representing 19 species of strepsirrhine primates and 5 locomotor groups were molded, digitized via  $\mu$ CT. Dimensions of the individual volar pads were digitally quantified and standardized by body size. Discriminant function analysis was employed to identify shared traits specific to broad locomotor groups and narrow phylogenetic comparisons between locomotor groups were conducted at the family level to identify features shared by closely related taxa that may have been obscured in the broader analysis. Results of these comparisons indicate that significant differences in volar pad morphology are present between locomotor groups and correlate well with known osteological and behavioral data. These differences in morphology become more stark when narrow phylogenetic groups are considered; in particular, lemurid and galagid taxa exhibit numerous differences between quadrupedal and vertical clinging and leaping groups, but only when narrowly considered.

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### Possible idiopathic scoliosis in a bonobo

CLAIRE A. KIRCHHOFF<sup>1,2</sup> and HALLIE M. S. LLOYD<sup>3</sup>  
<sup>1</sup>Biomedical Sciences, Marquette University, <sup>2</sup>Center for Anatomical Sciences, University of North Texas Health Science Center, <sup>3</sup>Unaffiliated

Spine researchers have hypothesized that only humans experience idiopathic scoliosis, and that the condition is related to human obligate bipedalism. Published cases support this idea, as they involve captive primates and are likely to document congenital rather than idiopathic scoliosis. In contrast, recent work on animal models for scoliosis questions the relationship between bipedality and idiopathic scoliosis. We present the case of a wild-shot adult male bonobo (*Pan paniscus*) with several skeletal symptoms consistent with idiopathic scoliosis – the first report of this condition in a wild primate. The complete skeleton is housed at the Royal Museum for Central Africa (Tervuren, Belgium), was evaluated for skeletal trauma and pathology, and compared with two asymptomatic skeletons. Visual assessment of the vertebrae included evaluating the presence of morphologic features associated with scoliosis. Directional asymmetry of lateral vertebral body heights was also calculated. The complete vertebral column was available for inspection, and no morphological abnormalities suggestive of congenital scoliosis (e.g., hemivertebrae) were observed. The first and second lumbar vertebrae exhibit lateral wedging and horizontal torsion of the vertebral body, as well as an asymmetric neural arch, articular facets, and transverse processes. Directional asymmetry was an order of magnitude higher in the symptomatic animal compared to the asymptomatic skeletons. The possible presence of this condition in a wild bonobo provides more evidence to challenge the hypothesis that idiopathic scoliosis may be a cost of bipedalism. Further study of scoliosis in our closest relatives may elucidate the etiology of this complex condition in humans.

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### Something To Chew On: Comparing Dentin Exposure in Ancient Egyptians and Dental Age Estimation Standards

CASEY L. KIRKPATRICK  
Anthropology, University of Western Ontario

Biological age estimation is central to every study of human remains, modern and ancient. Dental age estimates can be: influential in the identification and individuation of human remains and the reconstruction of osteobiographies, important to the differential diagnosis of paleopathology, necessary to the study of paleo-demography, and relevant to age determination in living individuals for legal purposes or sociocultural studies. Consequently, the accuracy and specificity with which we can produce age estimates is of supreme importance.

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With the exception of the site-specific Miles (1962) method, macroscopic dental age estimates for adult human remains are currently determined through the use of 'universal' standards based on North American and European reference populations. This paper presents the comparison of dental attrition presented in 'universal' standards and in photographic records of the dentition of individuals exhumed from the Dakhleh Oasis, Egypt. The dental attrition in the universal standards and the photographs of the Egyptian dentition were analysed through the use of digital image analysis software (ImageJ), which allowed for the quantification of dentin exposure relative to the crown area of each tooth. This study demonstrates the need for region-specific macroscopic adult dental age estimation standards based on the significant differences between the attrition presented in 'universal' standards and that seen in the ancient Egyptian dentition.

### Visitor effects on Western Lowland Gorillas (*Gorilla gorilla gorilla*)

ALISON KIRWEN

Anthropology, Iowa State University

Considering the unique difficulties that come from housing bachelor groups of gorillas in zoos it is vital to be able to address any behavioral concerns brought about by complications of visitor effects. Five male western lowland gorillas (*Gorilla gorilla gorilla*) were observed at the St. Louis Zoo between June and July 2014. Data were collected on gorilla activity as well as interactions between visitors and the gorillas. Visitors were classified by their perceived size, age, gender, race, and the type of behavior they were participating in (innocuous, negative, or positive). Age was significantly related with rates of disruptive behaviors. Likewise, perceived race was significantly related to visitor behavior. Size was a significant factor in predicting the type of motivational behavior of a visitor. Sex was insignificant as a predictor of whether or not the individual will provoke a response from the gorilla. Visitors overwhelmingly participated in negative behaviors (i.e. knocking and yelling) in 56% of samples. Visitors also perpetuate heteronormative perspectives while they interpret the bachelor group's familial makeup. In the future, improvements in education and marketing zoos as places of conservation instead of fun parks could create less disruptive patrons. With regard to animal husbandry, rotating which gorillas are on exhibit could help with the fission/fusion patterns of bachelor groups that are not being met in captive environments. Another possibility is using ambient, naturalistic sounds inside of the gorilla habitats to habituate their auditory expectations and, as such, reduce the effects of disruptive visitors.

### The database of Worldwide Instances of Symbolic Data Outlining Modernity

MARC KISSEL and AGUSTIN FUENTES

Anthropology, Notre Dame

When and where humans became fully modern is an open question in human evolutionary studies. The anatomical and genetic changes have been well-studied, as have the archaeological indicators of modern human behavior, but these data are rarely linked together. We provide an updated and fully-working version of an open-access database, "Worldwide Instances of Symbolic Data Outlining Modernity," that records the available archaeological evidence of human symbolic action from <1,000,000 years ago to 45,000 years ago, alongside fossil data from these sites. This database is fully searchable and queryable and can be accessed online by anyone. It is linked to Leaflet to produce maps of different artifact types as well as locations of sites and hominin finds, and can be exported to GIS programs as well. Here, we show how to interact with the database and how it can be used to ask salient questions about human origins. We show that 1) there are multiple 'core regions' where behaviors that produced material evidence of symbolic thought appear; 2) that these behaviors are not linked to a single taxa in the genus *Homo*; and 3) that early material examples of symbolic thought precede well-dated instances of Anatomically Modern Humans. Cluster analysis shows that sites group together, suggesting information sharing at 100,000 years ago and earlier. Information is spreading between sites in ways which, while not fundamentally different from the way many anthropologists would assume it occurred, contradict the assumptions of low information transfer in some models of human evolution.

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### Is Broca's cap really larger on the left in modern humans? Contradictory evidence via Non-rigid diffeomorphic mapping methods

LINDSEY M. KITCHELL

Cognitive Science, Indiana University

The Broca's cap region on endocasts is an area of great interest because of its location overlying brain regions that are relevant to aspects of language production. It is thought that in modern humans, Broca's cap is asymmetric with the left side larger than the right. However, this claim is based on qualitative observations that are susceptible to bias and has recently been called into question by Balzeau et al. 2014. This study is an assessment of Broca's cap asymmetry in modern humans using a non-rigid diffeomorphic registration method borrowed from neuroscience. Virtual endocasts of modern humans were mirrored and diffeomorphically mapped

back into the original version using the Advanced Normalization Tools software package, creating transformation maps that indicated where voxels from the original endocast image map to voxels on the mirror image. Jacobians, unit-less measures that quantify how much larger or smaller a point in space in the mirror image is compared to the corresponding point in the original image, were calculated at each voxel on the transformation maps. Preliminary results based on 28 modern human endocasts indicate that on average Broca's cap is actually larger on the right side, contradictory to previous qualitative studies. Based on the average Jacobian values, Broca's cap was found to be around 10% larger on the right than the left. When examined individually, 17 (61%) endocasts showed a clear rightward asymmetry, 5 (18%) a clear leftward asymmetry, 4 (14%) a complex asymmetry and 2 (7%) no asymmetry.

### Central Asian Turkic and Indo-Iranian Genetic, Linguistic, and Geographic Differentiation

AMANDA G. KITTOE<sup>1</sup>, FRANZ MANNI<sup>2</sup>, ÉVELYNE HEYER<sup>2</sup> and PHILLIPE MENNECIER<sup>3</sup>

<sup>1</sup>Anthropology, University of Kansas (KU), <sup>2</sup>Genetics, Musée de l'Homme (Paris, France), <sup>3</sup>Linguistics, Musée de l'Homme (Paris, France)

This study examines the overall genetic structure of Turkic- and Indo-Iranian-speaking populations of Central Asia (Uzbekistan, Kyrgyzstan, and Tajikistan), of which ethnicities Karkalapak, Kazakh, Kyrgyz, Turkmen, Uzbek, Tajik and Yaghnobi are represented. This study is an international collaboration between American and French genetic and linguistic anthropologists. AMOVA and Mantel tests are used to examine the relationship between genetic differentiation, linguistic differentiation, and geographic distance; the results of which lead to a larger discussion of how cultural factors, such as language, influence the genetic composition of a society. Genetic samples were provided by E. Heyer and consist of mitochondrial HVR-1 sequences from 948 individuals and 8 y-chromosome microsatellites from 837 males. A linguistic distance matrix was provided to the first author by F. Manni and P. Mennequier, and contains 25 samples which represent six languages categorized into either Turkic (Karakalpak, Kazakh, Kyrgyz, and Uzbek) or Indo-Iranian (Tajik and Yaghnobi) language groups. Linguistic distances were calculated using the Levenshtein Distance method. The linguistic distance matrix was used to calculate correlation with group-pairwise genetic and geographic distance matrices. Results show significant differentiation for both maternal and paternal lineages based on sample site, ethnicity and language group. Each lineage displays the highest among-group variation based on sample site, followed by ethnicity, and then language

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group. However, there lacks significant relationships between genetic distance, linguistic difference, and geographic distance. The results suggest that though time, shared ethnicity and language contribute to group differentiation, but geographic proximity is a weaker factor for societies inhabiting Central Asia.

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### Extractive foraging in wild Tana River Mangabeys, *Cercocebus galericus*: Implication of Different Physical Properties of Foods

STANISLAUS M. KIVALI

Anthropology, Rutgers University & Institute of Primate Research, Kenya

Primates exhibit complex foraging behavior. Compared to other mammals, their feeding involves a combination of complicated manipulative behaviors to process and ingest food. This is particularly true for the consumption of mechanically challenging foods, which may exert selection pressure for cognitive adaptations to find and process rare or hard foods. Here we report observation of extractive foraging behavior in the wild Tana River mangabeys, *Cercocebus galericus*, and present data on food hardness indentation to explain this behavior. We collected behavioral data through focal sampling and measured hardness using the FLS-1 tester machine. Field observation showed that the Tana River mangabeys used tree trunks, branches or dead logs as substrate to process fruits from *Oncoba spinosa*, *Diaspyros mesipiliformis* and *Saba comorensis* trees, a behavior never reported before. Except for the *O. spinosa* fruits from *D. mesipiliformis* and *S. comorensis* exudate sticky substance when cut open. Mean hardness indentation was higher in *O. spinosa* ( $353 \pm 52.51$  (SEM)) compared to *Diaspyros mesipiliformis* ( $9.21 \pm 3.55$ ) and *Saba comorensis* ( $4.59 \pm 2.08$ ) (Kruskal Wallis and multiple comparisons test,  $p < 0.0001$ ). All fruit species were processed the same way despite differences in hardness. These results suggest that other food properties such as stickiness other than mechanical properties like hardness may better explain food-processing behavior for Tana River mangabeys.

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### It's all in the wrist: New Neandertal carpal bones from El Sidrón (Asturias, Spain)

TRACY L. KIVELL<sup>1,2</sup>, ALMUDENA ESTALRRICH<sup>3</sup>, ROSA HUGUET<sup>4</sup>, ANTONIO GARCIA-TABERNEO<sup>3</sup>,

LUIS RIOS<sup>5</sup>, MARCO DE LA RASILLA<sup>5</sup> and ANTONIO ROSAS<sup>3</sup>

<sup>1</sup>School of Anthropology & Conservation, University of Kent, <sup>2</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>3</sup>Department of Paleobiology, Museo Nacional de Ciencias Naturales-CSIC, <sup>4</sup>Institut Catala de Paleoeologia Humana i Evolucio Social (IPHES), Unidad Asociada al CSIC, <sup>5</sup>Department of History, Universidad de Oviedo

Twenty-eight adult carpal bones of *Homo neanderthalensis*, representing all elements of the wrist, have been uncovered from the site of El Sidrón (Asturias, Spain) between 1994-2010 and dating to 49,000 years old. Within this sample, several carpal bones can be associated to the same individual with reasonable certainty to make up a complete right carpus. Here we provide a qualitative and quantitative comparative morphological description of these carpal bones, focusing on the scaphoid (n=6), trapezium (n=2), capitate (n=5) and hamate (n=2). The morphology is discussed within the context of other European and Near Eastern Neandertals, early and recent *H. sapiens*, and other fossil hominins, including australopiths and *H. naledi*. Overall, the carpal morphology of the El Sidrón sample shows many of the typical characteristics that distinguish Neandertals from *H. sapiens*, including a relatively flat, broad trapezium-first metacarpal articulation and a more radially-oriented capitate-second metacarpal facet. However, there are several features of El Sidrón carpal bones that distinguish them from other Neandertals; the tubercle of the trapezium is small with limited projection, while the scaphoid tubercle and hamate hamulus are among the largest compared with all known Neandertals. Furthermore, of the six scaphoids found, half show a fused but distinct "os-centrale portion", while another is a bipartite scaphoid. This high frequency of developmental abnormalities offers support to previous evidence of a close genetic relationship among the 13 individuals found at El Sidrón.

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### Keep your Head High - Mesolithic Crania Mounted on Stakes at Kanaljorden, Sweden

ANNA S.E. KJELLSTRÖM<sup>1</sup>, SARA GUMMESSON<sup>1</sup> and FREDRIK HALLGREN<sup>2</sup>

<sup>1</sup>Department of Archaeology and Classical Studies, Osteoarchaeological Research Lab., Stockholm University, <sup>2</sup>The Cultural Heritage Foundation, Västerås, Sweden

During excavations 2009-2013 at the site Kanaljorden in east-central Sweden, disarticulated human crania and animal deposits were

discovered on a stone packing on the bottom of a previous lake. The context is dated to c. 8000 – 7500 cal BP. Wooden stakes were recovered in two crania indicating they had been mounted. Additionally, preserved remains of a human brain were recovered, attesting to good preservation and the conditions of the crania deposited.

Few sites belonging to this period have been investigated in Scandinavia, and the knowledge dealing with socio-cultural behaviour is low emphasizing the importance of an interpretation.

A detailed osteological investigation using standard anthropological (and zooarchaeological) protocols on the complete osseous material was performed. Special attention was given to taphonomic and trauma analyses.

Nine crania from adults of both sexes and an almost complete infant skeleton were identified. The majority of the adults exhibited antemortem blunt force trauma likely as a result of interpersonal violence. The trauma pattern is sex related, with injuries exhibited on the back of the head of women and on the top of the head of men.

The demographic selection and the multiple healed injuries imply that the individuals were chosen. There are indications of a strict spatial organization and animal remains can be seen associated to the ceremonial deposition. Based on the taphonomic factors it is clear that the human bodies were modified or manipulated prior to deposition. The find challenges our understanding of the handling of the dead during the Mesolithic.

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### Reevaluating morphological sex estimation methods for the creation of a free user database

ALEXANDRA R. KLALES<sup>1</sup> and STEPHANIE J. COLE<sup>2</sup>

<sup>1</sup>Forensic Anthropology Program, Sociology & Anthropology Dept, Washburn University, <sup>2</sup>Applied Forensic Sciences, Mercyhurst University

We know that bioarchaeologists and forensic practitioners alike prefer morphological methods because of their ease of use, lack of need for specialized or expensive equipment, and the efficiency with which data can be collected. Because of this, morphological methods for sex estimation have been updated within the last decade to improve their accuracy and reliability, yet room for further improvement remains. Recognizing the need for updated standards in the field, the National Institute of Justice awarded a grant in September of 2015 for the creation of a morphological database for sex estimation. As part of this grant, morphological skull and pelvic data for eight commonly used traits from two popular sex estimation methods have been collected from over 1700 individuals to date to examine classification accuracy, observer reliability, temporal change, population differences, and the effects

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of asymmetry. Data were collected throughout the U.S. and internationally. Preliminary results indicate high classification accuracy and low observer error for most traits. Differences in trait score frequencies between different temporal periods suggest secular changes may be occurring. Additionally, recalibrating the original method equations for separate populations improved classification accuracy, thereby indicating that differences in populations exist and population specific equations are necessary. Lastly, while asymmetry did impact classification accuracy, the effect was minor and classification accuracy remained high. The information from this research will result in a free database that will be available in the early fall of 2017.

*The research is supported by National Institute of Justice grant 2015-DN-BX-K014.*

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### 4,000 Years of Cultural and Adaptive Transitions in Lambayeque: Skeletal Biology, Ecology, and Sociopolitical Interplays in Ancient Peru

HAAGEN D. KLAUS

Dept. of Sociology and Anthropology, George Mason University

Andean archaeology has long considered culture-ecology interactions, but simultaneously has been slow to engage broader anthropological/temporal frameworks or biohistorical approaches. This work presents an initial regional and diachronic synthesis of skeletal biological data (paleodemography, metabolic stress, infectious disease, oral health, isotopic variation, growth, osteoarthritis, trauma) of 2,500 individuals in a 4,000-year long sequence in the Lambayeque Valley Complex (north coast Peru). The sequence spans the origins of complex cultures to the Spanish colonial period as interpreted within Andean paleoenvironmental, archaeological, and *longue durée* theoretical frameworks.

Within this coastal desert, the bioarchaeological record indicates Formative-era societies (2600-650 B.C.) demonstrated particularly low morbidity and diets balancing marine and terrestrial resources, after which a long-term pattern of increasing biological stress and morbidity emerged. These trends coincided with negative anthropogenic transformations of desert river valley ecosystems, deforestation, demographic expansion, and agricultural intensification after 100 A.D., but appear unaffected by repetitive half-millennia long regional warm/dry late Holocene climate cycles – though episodic mass sacrifice and political collapses occurred in response to dramatic mega-El Niño oscillations circa A.D. 550 and 1100. Further, development of socioeconomic complexity and rigid social inequalities concentrated morbidity among non-elite populations by the Moche era (A.D. 100-750/800). This pattern persisted throughout

the remainder of prehistory and was significantly amplified following the postcontact adaptive transition. However, key exceptions exist, linked to unique influences of specific microenvironments on health and diet. The skeletal record of Lambayeque reveals human biology as an entanglement between economy and ecology and offers new orientations in Andean bioarchaeology.

*This work was generously supported by grants from the National Science Foundation, the Wenner-Gren Foundation, and the National Geographic Society since 2005.*

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### Age Related Changes in Trabecular Bone Structure in a Sample of Early Agriculturalists

DARCI J. KLEBECK<sup>1</sup> and TIMOTHY RYAN<sup>2</sup>

<sup>1</sup>Anthropology, Texas Tech University, <sup>2</sup>Anthropology and Center for Quantitative Imaging, The Pennsylvania State University

Osteoporosis is the systematic loss in bone mass and density, leading to an increased risk of fracture due to the resulting fragility. In spite of the significant health implications of bone loss, our understanding of the incidence and significance of osteopenia and osteoporosis in the archaeological record remains incomplete. The goal of this study was to compare three-dimensional trabecular bone structural changes in the wrist of females in relation to aging in an archaeological population. The right distal radius from a total of 15 individuals from the Norris Farms #36 archaeological skeletal collection were divided into three age groups, each containing five individuals: pubescent, premenopausal and postmenopausal. The estimated age range of the individuals in the sample was 16-84. The distal radius of each individual was visually examined for the presence of Colles fractures then microCT scanned in the Penn State Center for Quantitative Imaging. The trabecular bone structure of the distal radius was segmented from the surrounding cortical bone using a dual threshold approach. Trabecular bone structure was then quantified using Medtool and BoneJ. The results indicate that there are no significant differences between the three age groups in bone volume fraction. The oldest individuals, in some cases, have higher bone volume fraction than the younger premenopausal women. While these results may be indicative of more sustained loading of the forelimb due to higher activity levels in this population, they also likely reflect the Osteological Paradox.

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### Genome Partitioning and Telomere Length in Primates and other Mammals

AMY R. KLEGARTH<sup>1,2</sup> and DANIEL TA. EISENBERG<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Washington, <sup>2</sup>Center for Studies in Demography and Ecology, University of Washington

Telomeres are repeating non-coding DNA sequences that cap and protect the ends of chromosomes from mitotic degradation. Individual chromosome arms have a specific telomere length (TL), and studies in humans show a strong, positive correlation between the length of a chromosome and that chromosome's TL ( $r=0.6-0.79$ ). Similar associations have also been observed within species of rodents, angiosperm plants, and protozoans. While the reasons for these associations are unclear, the strength and consistency of them across taxa suggest these patterns are important to telomere biology. Understanding the genomic determinants of TL is particularly pressing given the increased attention TL has received in recent studies on human and primate health. If TL is primarily determined by chromosome length, then this factor may need to be controlled for in cross-species analyses of TL. For example, in species with identical genome sizes, but one species having 4 chromosomes and the other 40, we would expect the species with more, shorter chromosomes to have a shorter mean TL. Here we employ a phylogenetic generalized least squares approach to explore whether the chromosome length-TL association observed intraspecifically, persists across species using data compiled from two studies. Contrary to expectations, mean TL was inversely correlated with chromosome size across five primate species ( $r=-0.58$ ;  $p=0.03$ ) and no significant association with mean chromosome size was evident across mammals broadly ( $n=40$ ;  $p>0.25$ ). These unexpected results leave the strong intra-species association between chromosome size and TL unexplained and this major component of telomere biology shrouded in mystery.

*For training in phylogenetic comparative methods, we thank the AnthroTree Workshop which is supported by the NSF (BCS-0923791) and the National Evolutionary Synthesis Center (NSF grant EF-0905606).*

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### Maternal environment and the composition of breast milk immune proteins in mothers from urban and rural Poland

LAURA D. KLEIN<sup>1</sup>, ELISHA GOONATILLEKE<sup>2</sup>, ANDRZEJ GALBARCZYK<sup>3</sup>, ANNA KOTLINSKA<sup>3</sup>, CARLITO LEBRILLA<sup>2</sup>, GRAZYNA JASIENSKA<sup>3</sup> and KATIE HINDE<sup>1,4</sup>

<sup>1</sup>Department of Human Evolutionary Biology, Harvard University, <sup>2</sup>Department of Chemistry, University of California-Davis, <sup>3</sup>Department of Environmental Health, Jagiellonian University, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University

Breast milk contains immune molecules that provide protection and education to the infant

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during a critical and vulnerable period while its own immune system develops. These molecules, particularly immune proteins, are thought to reflect the mother's lifetime immune exposures and prepare the infant's immune system to cope with challenges it will face in its local environment. The composition of milk immune proteins is known to vary within and among populations. However, what specific aspects of the environment shape this variation is not well understood. Here we investigate how the maternal environment relates to immune protein concentrations in milk collected during a longitudinal study of mothers in Krakow (n=18) and at the Mogielica Human Ecology Study Site (n=33) in Poland. Immune proteins were analyzed using triple-quadrupole/time-of-flight mass spectrometry. Guided interviews were used to collect data about participants' current and childhood environments, such as household location and composition, contact with domestic animals, and participation in agriculture. Living on a farm was associated with greater exposure to potential pathogen sources, but contrary to predictions was associated with lower levels of several immune proteins. For example, farmers had lower concentrations of Secretory IgA (mean  $\pm$  SD:  $0.39 \pm 0.07$  g/L) than women in rural, non-farming ( $0.46 \pm 0.28$  g/L) or urban areas ( $0.48 \pm 0.12$  g/L). Understanding how mother's milk is shaped by the environment will ultimately help determine how infants use varying signals in milk to build their own immune systems, likely contributing to the variation observed in adult immune function among populations.

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### Fifteen Years of Forest Fragmentation in Southeastern Madagascar: Making sense of Fragmented Results

KATHERINE J. KLING<sup>1</sup>, Z. ANSELMO ANDRIANDRASANA<sup>2</sup>, ALEX DEHGAN<sup>3</sup> and PATRICIA C. WRIGHT<sup>1</sup>

<sup>1</sup>Anthropology, Stony Brook University, <sup>2</sup>Paleontology and Biological Anthropology, Université d'Antananarivo, <sup>3</sup>Conservation X Labs, Washington, DC

Fragmentation of primate habitats is a dynamic process and one of immense importance for both understanding primate behavioral flexibility and guiding best conservation practices. While fragmentation is well-explored within forested landscapes, its effects are difficult to generalize, particularly as fragmentation studies are infrequently framed within a long-term context. To address the deficit in follow-through in fragmentation research, we undertook a comparative study of eight forest fragments near Ranomafana National Park (RNP) in southeastern Madagascar across two study periods: December-May

1999-2001 and June-August 2016. We conducted transect surveys (500 m; N = 192, 1999-2001; N = 62, 2016) to determine occupancy of the fragments by lemur species native to RNP, calculated current fragment size and systematically recorded signs of human disturbance. To assess species vulnerability to habitat loss across the total study period, we viewed survey results within the context of population viability analyses (PVAs) modelled using Vortex 10 of two diurnal (*Propithecus edwardsi* and *Eulemur rubriventer*) and two nocturnal (*Microcebus murinus* and *Avahi laniger*) lemur species endemic to the study region. Fragment size decrease was dramatic and wide-ranging (mean:  $43.5 \pm 53.97\%$ ), demonstrating widely-varying historical contexts. *Microcebus murinus* was the most commonly sighted primate across both study periods, while *Propithecus edwardsi* was not observed in the latter (2016), indicating differential responses across species to fragmentation processes. This study reveals the importance of long-term research within fragmented regions in capturing compositional changes across time and space, essential for best advising the allocation of scarce resources toward conservation efforts.

*Special thank you to the RW Fund and the International Primatological Society Conservation Grant in supporting this research.*

### Two recently excavated Megalithic gallery graves in Erwitte-Schmerlecke (North Rhine-Westphalia) from the Wartberg Culture (3500-2800 BC) with focus on the investigation of their builders

SUSAN KLINGNER and MICHAEL SCHULTZ

Anatomy and Embryology, Georg-August-University Göttingen

Knowledge about megalithic societies from the Wartberg culture (3500-2800 BC) in Central Europe is a desideratum in anthropological and archaeological research. Fortunately, two Gallery Graves could be excavated from 2009 to 2013 within the framework of an interdisciplinary research project. Amongst other skeletal elements, 1081 femora and femur fragments from grave one, 4534 teeth from grave one and 5902 teeth from grave two were examined. Methods applied were of forensic anthropological nature, for example, sorting more than 60,000 commingled bones, teeth and fragments and estimating the minimum number of individuals from one skeletal element. For paleopathological analyses, macroscopic, radiological and endoscopic examinations took place first and also low power microscopy, light microscopy, scanning electron microscopy and biochemical analyses. For the histological estimation of age at death, thin ground sections were prepared. Based on femora examination, the minimum number of individuals is 216. All age groups are present. Sex and stature were estimated and a high frequency

of deficiency diseases in children (100%) and physical strain in adults (82%) was found. The frequency of osteoarthritis in the large joints is very low (hip 7%, knee 7%). The importance of a careful excavation and examination of isolated teeth is shown by the estimation of the minimum number of individuals in grave one with 324 and in grave two with 446 buried individuals. These numbers represent more individuals than estimated before, also with respect to Megalithic tombs already investigated. Valuable conclusions about diet and the way of living could be drawn.

*The project (Schu 396/31) was funded by the German Research Foundation and was part of the Priority Program 1400 (Early Monumentality and Social Differentiation).*

### Subadult Stress: continental Croatia vs Adriatic coast

MARIJANA KLJAJIC LUKACEVIC<sup>1</sup>, MARISSA WOJCINSKI<sup>2</sup> and MARIO SLAUS<sup>3</sup>

<sup>1</sup>Department of Archaeology, University of Zagreb Faculty of Humanities and Social Sciences,

<sup>2</sup>Department of Anthropology, University of North Carolina at Chapel Hill, <sup>3</sup>Anthropological Centre, Croatian Academy of Sciences and Arts

The poster presentation will present the results of an analysis of frequency and distribution of subadult stress at the archaeological site Torcec-Cirkvisce.

The archaeological site Torcec-Cirkvisce is a late medieval and early new age cemetery. It is located approximately 125 km east of Zagreb, in the continental part of Croatia. The mortuary sample consists of 25 subadults and 60 adults. Average adult female age at death is 36.5 years, compared to 41.7 years in adult males. The frequencies of enamel hypoplastic defects are most frequent in the mandibular canines: 84.6% (n=26) exhibit one or more hypoplasia. *Cribr orbitalia* is observed in 22 (51.2%) of the 43 crania with intact orbits. The frequency of *cribra orbitalia* at the adults is 42.9% while at the subadults is 66.6%. Slightly more than 70% in the total sample exhibit at least one periosteal lesion on any bone (adults= 46.6%; subadults= 50%).

The data will be compared with three other archaeological sites: Suhopolje, Koprivno and Rijeka. Suhopolje is located in continental Croatia while Koprivno and Rijeka are located at the Adriatic coast.

Total sample from Suhopolje consists of 76 skeletons, Koprivno 146 and Rijeka 115 skeletons. About 50% of samples from Suhopolje, Rijeka and Koprivno have enamel hypoplastic defects. The frequency of *cribra orbitalia* at the samples from Suhopolje, Rijeka and Koprivno is about 25%. More than 50% in the total samples from Koprivno and Rijeka exhibit at least one periosteal lesion on any bone.

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### Canine Tooth Robusticity mitigates Stress in the Jaw

ZACHARY S. KLUKKERT

Department of Anthropology, City University of New York Graduate Center (CUNY); New York Consortium in Evolutionary Primatology (NYCEP)

Primate tooth crown height is understood to correspond with competitive social regimes. The functional significance of the relative thickness, or robusticity, of canine teeth is assumed to correspond with forces during feeding. In one study, beam theory was used to estimate bending resistance, but tooth fracture data are inconsistent with predictions based on the beam model. This paper hypothesizes that mitigation of the stresses in the jaw, not the tooth, is the principal constraint of the tooth geometry where it meets the alveolar bone at the CEJ. Initial observations using finite element models of CT-scanned canine teeth revealed a pattern whereby the CEJ region experienced higher stresses during vertical and orthogonal loading than mid-crown loci. Using a simplified canine model to further explore the distribution of stress under multiple loading regimes, yield values of three tissues (enamel, dentine, cortical bone) were used as driving constraints to find the optimal geometry for the loads. Constraining the model with cortical bone values in the alveolar tissue resulted in an optimal model that approximated the dimensions and stresses of the CT-scanned primate canine teeth under the same loads. These results are consistent with the hypothesis that structural failure of alveolar bone should precede that of harder tissues in the tooth itself when the canine tooth is in use. In contrast to previous findings, canine robusticity may primarily be an adaptation for the reduction of critical stresses in the jaws during loading on the teeth as opposed to resistance to bending along the crown.

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### How selection shapes primate major histocompatibility complex polymorphism

LESLIE A. KNAPP

Anthropology, University of Utah

Major histocompatibility complex (MHC) genes are highly variable in humans, non-human primates and other vertebrates and the MHC plays an important role in immune response to infectious disease. In humans, MHC heterozygosity is as high as 80-90% and this unparalleled finding has prompted many researchers to investigate the high degree of polymorphism in the context of natural selection and other evolutionary forces. Studies in several species support the argument that MHC genes also influence individual odors used in mate choice. Since the MHC is used for cellular discrimination of "self" and "non-self", this genetic system might even be

useful for detecting related individuals that share unique combinations of MHC alleles. Although evidence for MHC-based kin recognition or mate attraction in any species is limited, it is possible that odor, color or other phenotypic markers advertise individual MHC genotypes. In this talk, I will review some of the unique and most interesting properties of the MHC and will discuss what we currently know about the relationship between selection and MHC polymorphism in primates.

### Integration of the Anthropoid Skull: An Ontogenetic Perspective with Insights into Jaw Fusion

RYAN P. KNIGGE

Department of Anthropology, University of Minnesota

It is hypothesized that mandibular symphyseal fusion in anthropoids is a complex character because it is functionally integrated with multiple other skull components, constituting an evolutionary stable configuration. Due to canalization of these structures, it is expected that symphyseal fusion, and its integrated components, should be maintained even if no longer functionally necessary. Based on previous analyses differentiating anthropoid and strepsirrhine skull form: function, symphyseal fusion is hypothesized to correlate with increased relative brain size, basicranial flexion, facial kyphosis, higher temporomandibular joint, taller ascending ramus, and vertically-oriented masseter muscles. As growth and development determine how morphological relationships manifest in adults, this study takes an ontogenetic perspective in testing the hypothesized relationships in skull morphology associated with jaw fusion. Skulls from a comparative ontogenetic sample of primates including *Gorilla gorilla* (N=25), *Macaca fascicularis* (N=25), *Cebus apella* (N=25), *Lemur catta* (N=24), and *Propithecus verreauxi* (N=24) were digitized to create 3-D landmark configurations, subsequently aligned using a generalized Procrustes analysis. Two-block partial least squares analyses on the mandible and cranium were implemented for each taxon and for pooled anthropoids and strepsirrhines. Results show similar patterns of skull integration during ontogeny across these primates, but the relationship between cranium and mandible is opposite from what was hypothesized. These results suggest that although previously observed functional relationships exist across taxa in adults, these relationships do not appear to be integrated during ontogeny and do not support previous hypotheses of a uniquely integrated anthropoid skull. Nevertheless, further investigation is needed to document other potential variations in ontogeny.

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### Foraging Efficiency and Ecological Risk Aversion in Juvenile Bornean Orangutans

CHERYL D. KNOTT and KAELIN E. DELONG

Anthropology, Boston University

For species with low mortality and high reproductive costs, like primates, rather than maximize reproduction, natural selection should favor slow growth and slow reproductive rates. Orangutans, because of their slow life history, and the extreme fluctuations in their food supply, are hypothesized to have been selected for slow juvenile development to avoid ecological risk. Juveniles are predicted to be particularly vulnerable during periods of low food availability because of lower foraging success. Thus, we tested the hypothesis that juvenile orangutans are less efficient foragers than adults and that they are less able to both access and digest important fall-back foods. Data were collected on wild orangutans in Gunung Palung National Park, Borneo, Indonesia between 1994-2016. Analyses are drawn from 468 matched follows of mother-offspring pairs in which more than 75% of the diet has been analyzed. We found that juveniles ate fruit when their mother's ate fruit during 98.3% of bouts. However, for other food items, juveniles were much less likely to eat the same food items (insects = 65.2%, leaves 76.5, bark 70.0%, flowers 75.0%, pith 65.8%). As expected, we found that juveniles ate significantly fewer calories than did adults overall, but this difference was particularly pronounced during periods of low food availability ( $p < 0.001$ ). We show that these results were due to constraints on both the processing and digesting of fall-back foods. Thus, the long period of orangutan growth and dependency may reflect a risk-averse growth strategy in this forest characterized by dramatic fluctuations in preferred fruits.

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### Manipulation of the dead: exploring delayed burial practices at Neolithic Çatalhöyük

ELINE M.J. SCHOTSMANS<sup>1</sup>, SCOTT D. HADDOW<sup>1</sup>, MARIN A. PILLOUD<sup>2</sup>, MARCO MILELLA<sup>3</sup>, BONNIE GLENCROSS<sup>4</sup>, BARBARA J. BETZ<sup>5</sup> and CHRISTOPHER J. KNÜSEL<sup>1</sup>

<sup>1</sup>PACEA UMR 5199, University of Bordeaux, France, <sup>2</sup>Anthropology, University of Nevada, Reno, USA, <sup>3</sup>Anthropology, University of Zurich (CH), <sup>4</sup>Archaeology and Classical Studies, Wilfrid Laurier University, Waterloo, Ontario, Canada, <sup>5</sup>Anthropology, The Ohio State University, Columbus (OH), USA

Funerary customs in the Neolithic Near East encompass a range of practices, including intramural primary and secondary burials, as well as the retention of skeletal elements, especially

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of crania and mandibles. At the Neolithic site of Çatalhöyük in Turkey, there is renewed evidence for a period of delay between the death and burial of certain individuals. This evidence occurs primarily in the form of variation in the extent of skeletal articulation and flexion among primary interments. Some skeletons are fully articulated, while others show evidence of joint disarticulations and/or missing elements. Additionally, many individuals were interred in extremely hyperflexed positions. Such positions would be difficult to achieve with a fully fleshed body. Based on these observations, it is hypothesized that some bodies were processed post-mortem in such a way as to reduce or remove soft tissue body mass. This study investigates whether tightly flexed individuals underwent desiccation and/or defleshing prior to interment through detailed taphonomic analyses of the human remains and of the depositional environment of the grave itself.

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### Development of Dental Cementum Increment Analysis for Age at Death Determination within the Identification Process of Unaccounted-for US Service Members

KATRIN KOEL-ABT<sup>1</sup>, NICHOLAS D. WILSON<sup>2</sup> and KRISTINA N. SCHMIDT<sup>3</sup>

<sup>1</sup>Laboratory, DPAA, <sup>2</sup>Dental Clinic, Schofield Barracks, <sup>3</sup>Laboratory, DPAA

The Defense POW/MIA Accounting Agency (DPAA) conducts global search, recovery, and laboratory operations to identify unaccounted for Americans from past conflicts in order to support the Department of Defense (DoD) personnel accounting efforts. The interest in utilizing tooth cementum annulations to reliably determine the age of an individual has grown over recent years (Kagerer and Grupe 2001; Grosskopf and McGlynn 2011; Naji et al. 2014). This technique has shown promising results with a rather narrow age estimation error of 2-3 years from true chronological age. Further studies with the aim to develop a standardized method will strengthen the validity and increase the use in solving forensic cases. The present study utilizes tooth cementum analysis (TCA) in the blind to determine the age of 50 teeth of a sample of known-age active duty male and female US Service Members ranging from 18-50 years old, and representing a total number of 150 specimens. Each tooth had three sections of acellular cementum analyzed under a light microscope by three examiners, and new z-stacking software was utilized to enhance the images and with it the countability of cementum increments. A high interobserver agreement was found along with a

variance from true chronological age of under 3 years. The effects of age, tooth number, root type, pathology, and sex were all evaluated. Our group concludes that tooth cementum annulations can be reliably applied to assist in the estimation of age at death, and will be an additional asset in identifying unaccounted-for US Service Members.

*This project was supported in part by an appointment to the Research Participation Program for the DPAA, administered by ORISE through an agreement between the U.S. Department of Energy and DPAA.*

### Utilizing Isotope Analysis to Assess the Origins of Axis Combatants from World War II

KATHARINE E. KOLPAN<sup>1</sup>, IAN HANSON<sup>3</sup>, GEORGE KAMENOV<sup>2</sup> and JOHN KRIGBAUM<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>Department of Geological Sciences, University of Florida, <sup>3</sup>Deputy Director of Forensic Science for Archaeology and Anthropology, International Commission on Missing Persons

This study utilizes lead, strontium and oxygen isotope ratios to explore the life history and origin of World War II Axis-affiliated combatants whose remains were buried in what is currently Herzegovina, Bosnia and Herzegovina (BiH). Artifactual evidence associated with the remains, such as German identification tags and coins, suggest that they are of German origin. However, after the former Yugoslavia was subjugated and subdued in April of 1941, various Axis-affiliated military and paramilitary organizations controlled different areas of the country. Modern day BiH was mostly under the control of the newly formed, Ushasha-led, Independent State of Croatia (NDH) and the Axis military units present in BiH were primarily composed of German, Austrian, Croatian and Bosniak Muslim combatants. Therefore, it is possible these skeletal remains are from mixed group of individuals rather than German or Austrian nationals.

To investigate the origins of these individuals, molar teeth of 23 of these combatants were subjected to isotope analysis utilizing an MC-ICP-MS. While carbon and oxygen isotope results were more homogeneous, the lead and strontium results indicate that there is variation within the sample, suggesting that certain individuals with low <sup>206</sup>Pb/<sup>204</sup>Pb (17.8-17.9) and high <sup>87</sup>Sr/<sup>86</sup>Sr (0.7995-0.7115) are more compatible with western European origins, while other individuals exhibit high <sup>206</sup>Pb/<sup>204</sup>Pb (18.3-18.4) and low <sup>87</sup>Sr/<sup>86</sup>Sr ratios (0.7080-0.7086) more consistent with isotopic ratios expected in the Balkans. Therefore, it is possible that some of these military combatants are of local origin.

### James W. Wood's contribution to the "Rostock Manifesto"

LYLE W. KONIGSBERG and SUSAN R. FRANKENBERG

Anthropology, University of Illinois

The "Rostock Manifesto" was a "collegial call for new directions in paleodemographic research" (Hoppa and Vaupel 2002: 2) that had as a main tenet the estimation of mortality model parameters. This focus on mortality models was largely due to the influence of Dr. James W. Wood, who was the first author of a chapter on mortality models for paleodemography in the Rostock volume. A little known fact about the first Rostock meeting in 1999 was that all participants were given a common "assignment" to estimate the parameters of a mortality model for a target sample (273 males from Dr. Linda Klepinger's forensic cases) using data from a reference sample (737 males from Suchey's LA Coroner's sample). Only three of the twelve chapters in the Rostock volume made use of the Suchey reference data, but none of the chapters used Klepinger's target sample. This was because the Klepinger sample appeared to age in a different fashion from the Suchey reference sample. Eighteen years after the first Rostock meeting, we show that this apparent difference in aging was due not to the pattern of senescence, but rather to the inappropriate formation of the Suchey-Brooks scoring method from the original Todd method. Accounting for this problem, we used an exponential hazard model and a collapsed version of the Suchey-Brooks scores to estimate the mean and median ages-at-death in Klepinger's sample as 36.78 and 30.10 years. The actual mean and median for Klepinger's sample was 37.05 and 31 years.

### Genome-wide cytosine methylation differences between ancient hunter-gatherers and farmers

DILEK KÖPTEKİN<sup>1</sup>, GÜLŞAH M. KILINÇ<sup>2</sup>, AREV P. SÜMER<sup>2</sup>, MELIKE DÖNERTAŞ<sup>2</sup> and MEHMET SOMEL<sup>2</sup>

<sup>1</sup>Health Informatics, Middle East Technical University, <sup>2</sup>Biological Sciences, Middle East Technical University

Ancient DNA (aDNA) is a powerful source of information on human demographic history, but it can also shed light on ancient epigenetic modifications, particularly cytosine (CpG) methylation. Postmortem deamination of cytosines creates uracils from unmethylated cytosines and thymines from methylated cytosines. When sequencing libraries are prepared by uracil DNA glycosylase (UDG) treatment, this removes the uracils but leaves behind the thymines arising from deamination. Thus, ancient methylome maps can be produced from UDG-treated aDNA data, and were previously published from high-coverage UDG-treated ancient genomes. However, whether this approach is feasible for

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low-coverage genomes has remained unknown. Here we investigate the effects of dietary nutrients on genome-wide cytosine methylation by comparing methylation patterns of ancient farmers and contemporaneous hunter-gatherers, using low-coverage sequence data. In preliminary analyses, we used genomic sequence from 8,000-year-old hunter-gatherer individuals and predicted methylation signatures at CpG sites. Comparing the estimated methylation levels with levels calculated from modern human osteoblast cell lines, we found significant correlation across the two datasets ( $\rho = 0.247$ ,  $p$ -value  $< 0.00001$ ). This indicates that CpG methylation may be reliably detected even with low-coverage ancient genomes. We further test methylation differences in ancient hunter-gatherers and farmers from west Eurasia, focusing on genes identified as differentially methylated between modern hunter-gatherers and farmers, to provide a first catalogue of putative diet-related epigenetic changes in prehistory. Our study presents a novel application for archaeogenomics in studying the Neolithic transition.

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### A Comparison of Upper and Lower Molar Trait Associations in Modern Humans, *Australopithecus*, and *Paranthropus*

EMMA A. KOZITZKY<sup>1</sup> and SHARA E. BAILEY<sup>1,2</sup>

<sup>1</sup>Center for the Study of Human Origins, New York University, <sup>2</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Dental trait association has been well studied in modern humans, but not in extinct hominins. Previously unrecognized inter-trait association in extinct hominin dentition has implications for phylogenetic analyses, which assume independence of traits. Additionally, understanding trait associations would resolve whether including all molars rather than just key molars in a phylogenetic analysis is simply duplicating information. This study quantifies the co-expression of (i) hypocone and Carabelli's trait, and (ii) protostylid and cusp 7 expression in a sample of modern human ( $n=474$ ), *Australopithecus* ( $n=88$ ), and *Paranthropus* ( $n=75$ ) upper and lower molars. Co-expression was evaluated for different traits in the same molar and metamer co-expression of the same trait and pairs of different traits. Statistically significant correlations were not found for any pair of traits in the *Paranthropus* sample. Correlations between upper molar traits are significant only in modern humans. In modern human lower molars (i) protostylid expression is correlated between first and second molars ( $\tau=0.292$ ,  $p<0.01$ ), and second and third molars ( $\tau=0.28$ ,  $p<0.01$ ), and (ii) cusp 7 expression is correlated between first and second molars ( $\tau=0.243$ ,  $p<0.01$ ). Unlike

modern humans, protostylid and cusp 7 expression in *Australopithecus* is inter-correlated in third molars ( $\tau=0.6$ ,  $p<0.01$ ). Protostylid expression between second and third lower molars was the only pair of traits that was significantly correlated for both modern humans ( $\tau=0.28$ ,  $p<0.01$ ) and *Australopithecus* ( $\tau=0.637$ ,  $p<0.05$ ). In sum, lower molar correlation values were higher in *Australopithecus* than in modern humans, and different pairs of traits were significantly correlated in modern humans and *Australopithecus*.

### Mechanics of Hip Extension Characterize Arboreal-Terrestrial Trade-offs in Hominin Evolution

ELAINE E. KOZMA<sup>1,2</sup>, NICOLE M. WEBB<sup>1,2,3</sup>, WILLIAM E.H. HARCOURT-SMITH<sup>1,2,3,4</sup>, DAVID A. RAICHLÉN<sup>5</sup>, KRISTIAAN D'AOÛT<sup>6,7</sup>, MARY H. BROWN<sup>8</sup>, EMMA FINESTONE<sup>1,2</sup>, STEVEN R. ROSS<sup>9</sup>, PETER AERTS<sup>7</sup> and HERMAN PONTZER<sup>1,2,9</sup>

<sup>1</sup>Department of Anthropology, Graduate Center, CUNY, <sup>2</sup>New York Consortium in Evolutionary Primatology, <sup>3</sup>Department of Anthropology, Lehman College, CUNY, <sup>4</sup>Division of Paleontology, American Museum of Natural History, <sup>5</sup>School of Anthropology, University of Arizona, <sup>6</sup>Institute of Ageing and Chronic Disease, University of Liverpool, <sup>7</sup>Department of Biology, University of Antwerp, <sup>8</sup>Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, <sup>9</sup>Department of Anthropology, Hunter College, CUNY

Compared to the other apes, humans are efficient walkers and excellent endurance runners, but poor climbers. In this study we model the mechanical advantage of *semimembranosus*, *semitendinosus*, and *biceps femoris longus* in humans, other living apes, and monkeys. We test whether ischial morphology predicts experimental measurements of human and ape kinematics and muscle activation in different locomotor modes. We show that human pelvis reduce hip extensor moments but permit greater hip extension, which should improve walking efficiency (distance traveled /energy used). Ape pelvis allow for greater mechanical advantage of the hip extensors, particularly when the hip is flexed, enhancing climbing ability but limiting the range of hip extension and resulting in a crouched walking gait. We then apply these results to *Proconsul/Embo nyanzae*, and the early hominins *Ardipithecus ramidus*, *Australopithecus afarensis*, and *Australopithecus africanus*. *Proconsul/Embo* resembles African apes in its pelvic mechanics, while results suggest *Ardipithecus* was capable of almost human-like hip extension, but maintained the ability for powered hip extension during vertical climbing. Hip extension ability appears essentially human-like in *Au. afarensis* and *Au. africanus*.

### The effect of mobility and modernization on co-residence patterns in Batek hunter-gatherers: a longitudinal analysis

THOMAS S. KRAFT<sup>1,2</sup>, VIVEK V. VENKATARAMAN<sup>1,2,3</sup> and KIRK M. ENDICOTT<sup>2</sup>

<sup>1</sup>Department of Biological Sciences, Dartmouth College, <sup>2</sup>Department of Anthropology, Dartmouth College, <sup>3</sup>Department of Human Evolutionary Biology, Harvard University

Group living is a hallmark feature of many social species, including humans. Recent evidence in hunter-gatherers of a high degree of unrelatedness among co-residents has led some researchers to conclude that humans exhibit a unique co-residence structure. But previous studies present a static picture of hunter-gatherer co-residence, and therefore cannot speak to the ecological factors that influence variation in patterns of group living. Here we present the co-residence structure of Batek hunter-gatherers in Peninsular Malaysia, using longitudinal data collected between 1975 and 2016. We use these data to ask how reduced mobility and modernization (e.g. increased access to agricultural food products) have affected Batek co-residence patterns over time. We find that in the mid-1970's, the co-residence structure of mobile Batek bands closely resembled published results for other hunting and gathering populations. We also found that Batek co-residence patterns changed through time, resulting in overall decreases in within-camp relatedness as group size and the degree of settlement increased. However, these effects were mitigated in part by the spatial modularization of relatedness within camps, driven by the formation of clusters of primary kin. Our results demonstrate that hunter-gatherer co-residence is flexible and can be quickly adapted to modern conditions, and raise fundamental questions about how hunter-gatherer individuals choose who they want to live with and the dynamic process by which group membership is determined.

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### Sex Ratio Imbalance affects Marriage and Reproductive Decisions among Pumé Hunter-Gatherers

KAREN L. KRAMER<sup>1,2</sup>, RYAN SCHACHT<sup>1</sup>, RUSSELL D. GREAVES<sup>1,2</sup> and ADRIAN V. BELL<sup>1</sup>

<sup>1</sup>Anthropology, University of Utah, <sup>2</sup>Pumé Longitudinal Life History and AQUA Lab

For most of human history, we have lived in small groups of mobile hunter-gatherers. As in the past, contemporary foraging societies experience random fluctuations in sex-biased births and deaths that dramatically alter the number of adults available for marriage and reproduction. While these demographic shifts likely play

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a key role in managing social relationships and marriage systems, these outcomes remain unexplored. Individuals in small-scale societies have a number of possible strategies to adjust to these fluctuations, such as altering the timing of first birth, multiple partner marriage or migration. Using recent frequency dependent theoretical reformations within sexual selection theory, we explore the role of sex ratio imbalance on reproductive decision making. Using computationally-intensive Bayesian methods, we leverage over 30 years of longitudinal demographic and residential data on two groups of Pumé South American hunter-gatherers (n=220). We show that rates of birth, death and migration alter the demographic structure of populations spatially and temporally. Across our sample, the percentage of men varies interannually between 30% and 70%. These pronounced swings illustrate that adult sex ratios are far more variable than commonly assumed. We find that these variations in adult sex ratio affect patterns of pairbond formation, marriage stability, age-at-first-birth, fertility and residence. Our results offer explanation for the flexible marriage and residence practices typical among hunter-gatherers as they respond to stochastic demographic events affecting partner availability.

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### Testing Hypotheses for the Embryonic Origins of Primate Neocortical Expansion

ANJANA KRISHNAMURTHY<sup>1,2</sup>, ANDREW C. HALLEY<sup>2,3</sup> and TERRENCE W. DEACON<sup>2</sup>

<sup>1</sup>MIND Institute, UC Davis School of Medicine,

<sup>2</sup>Department of Anthropology, University of California, Berkeley, <sup>3</sup>Center for Neuroscience, University of California, Davis

Expansion of the primate neocortex, particularly in haplorhine lineages, is widely considered an adaptation central to the complex forms of behavior that define our Order. However, the developmental mechanisms responsible for primate neocortical expansion are only beginning to be understood. Developmental models have proposed that larger neocortices result from larger embryonic progenitor pools in either (1) the ventricular zone (VZ; radial unit hypothesis), or (2) the subventricular zone (SVZ; intermediate progenitor hypothesis). To test these hypotheses in a comparative dataset, we examine the relative volume of the embryonic ventricles – a proposed correlate of the relative role of the VZ in neocortical expansion – in a sample of eight primate (n=34) and eight non-primate mammalian species (n=57). Embryos were reconstructed from microscopic photography of sectioned tissue in museum collections, sorted according to an interspecies staging system (Carnegie Staging), and measures of embryonic brain and ventricle volume were calculated by measuring

areas of interest across serial sections along the axis of dissection (Cavalieri method). We present evidence that during early neurodevelopment, species with larger adult brains also exhibit larger embryonic ventricles relative to brain volume. Although primates have disproportionately larger neocortices, we found no evidence for a difference between primates and non-primates once adult brain size is accounted for. This suggests that while VZ expansion plays a role in the regular scaling of brain areas (including larger neocortices in larger brains), primate neocortical expansion may rely on proliferative regions further from the ventricular wall, such as the SVZ.

### Ancestral state reconstructions of dental development in Miocene fossil taxa

CHRISANDRA KUFELDT

Human Paleobiology, George Washington University

Primate fossil taxa from the Miocene are fundamental to understanding the evolutionary divergence between great apes and humans and remain an important taxonomic context with which to examine hominin evolution. Teeth remain the most abundant fossils, and reconstructing dental development using dental microstructure provides information on the life history of fossil taxa. While numerous studies have described dental development in Miocene fossils in relation to modern apes, none have evaluated whether the ontogenetic record preserved in dental microstructure provides insight into the evolutionary relationships of fossil and extant primate taxa. This study reconstructs the ancestral states of dental development by mapping character states onto the primate molecular phylogeny to determine whether the observed state in the fossil taxa corresponded with the expected ancestral state. The dental microstructure traits reconstructed included daily secretion rate, periodicity of long-period Retzius lines, extension rate, enamel formation times, and cuspal enamel thickness measured from a sample of 42 extant primates and combined with 14 Miocene fossil taxa taken from the literature. Results suggest that the fossil taxa *Anapithecus hernyaki* and *Victoriapithecus macinnesi* express character states consistent with the expected basal nodes for the Cercopithecoidea, with *Victoriapithecus* sharing more ancestral states with the expected ancestral state of the cercopithecini primates. The fossil ape taxa *Ekembo heseloni* expresses character states similar to suggested basal catarrhines and *Hispanopithecus laietanus* does not appear to share the expected ancestral state with *Pan* or any of the African apes.

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### Sorting Out the Past: An evaluation of MNI Methods

SONIA KUISMANEN

Archaeology, Anthropology & Forensic Science, Bournemouth University

Knowing the number of individuals is necessary for understanding commingled remains in an archaeological or forensic setting. This study evaluated the strength and weaknesses of the three methods, White's MNI, Knüsel and Outram's zonation, and Mack *et al.*'s landmark, used to calculate the minimum number of individuals (MNI) and the minimum number of elements (MNE). Previous research shows the production of differing MNI and MNE results. These methods were applied to a commingled assemblage from St. Augustine the Less, Bristol, UK and used to estimate the Number of Identified Specimens (NISIP), the MNI, and the MNE. Fragmentation analysis was also performed for percentage completeness and bone representation index (BRI). The results indicate different MNI and MNE values for each method: White's MNI 124, White 50% rule 102, zonation 148, and landmark 104. The difference between the zonation and White's MNI (50% rule) was the highest, while the landmark and White's MNI showed fewer differences. In addition, the results of the zonation method indicated an overestimate in MNI, revealing a flaw in the recording of the cranium. The White's MNI was shown to overestimate (no rule) or underestimate (50% rule) when conjoining-exercises were not possible. These findings give guidance to future research on commingled remains and aid in choosing the method best suited for the collection. Further research should be carried out on known collections of varying percentage completeness to allow for further testing of method accuracy for the estimates of MNI and MNE.

### Three-dimensional Subastragalar Rotation in *Macaca* using XROMM

SHARON KUO<sup>1</sup>, NICHOLAS J. GIDMARK<sup>2,3</sup> and CAROL V. WARD<sup>1</sup>

<sup>1</sup>Pathology and Anatomical Sciences, University of Missouri, <sup>2</sup>Biology, Knox College, <sup>3</sup>Organismal Biology and Anatomy, University of Chicago

Reconstructing the locomotor repertoires of fossil hominoids is difficult as they have no living analogs. Feet are particularly useful, as they contact the substrate directly, but making accurate inferences about their functional signal requires knowing the motions and position of the bones during gait. The subastragalar joint is primarily responsible for foot inversion and eversion, and calcanei and astragali are well represented in the Miocene hominoid fossil record. However, visualizing the three-dimensional, complex movements of these bones during locomotion has been challenging.

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We used x-ray reconstruction of moving morphology (XROMM) to visualize the subastragal joint and calculated three-dimensional rotations and translations of the astragalus and calcaneus in a cadaveric adult macaque on a flat surface and rounded pole. XROMM uses calibrated biplanar fluoroscopy of tantalum-marked bones to measure movements and integrates CT scans of the same specimens to reconstruct relative movements. We tracked motion of the tarsal bones and tibia during a simulated gait cycle and showed kinematic patterns on different substrates. One key difference was in subastragal long axis rotation, which was greater on the pole during dorsiflexion and plantarflexion (4.8 degrees on flat; 8.5 degrees on pole), whereas rotation about the mediolateral axis was greater on the flat surface (6.1 degrees on flat; 2.8 degrees on pole). This study demonstrates a method of visualizing intertarsal position and motion during gait, as well as the effect of substrate on foot posture. These data provide a basis for inferring foot use during locomotion in extant and fossil hominoids.

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### Jaw kinematics in South African Plio-Pleistocene hominins inferred from maxillary molar root morphology: Implications for species identification

KORNELIUS KUPCZIK<sup>1</sup>, VIVIANA TORO-IBACACHE<sup>2,3</sup> and GABRIELE A. MACHO<sup>4</sup>

<sup>1</sup>Max Planck Weizmann Center for Integrative Archaeology and Anthropology, Max Planck Institute for Evolutionary Anthropology, <sup>2</sup>Centro de Análisis Cuantitativo en Antropología Dental and Instituto de Ciencias Odontológicas, Facultad de Odontología, Universidad de Chile, <sup>3</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>4</sup>School of Archaeology, University of Oxford

Based on stable isotope analyses, the dietary ranges of the South African Plio-Pleistocene largely overlapped. Yet, enamel prism orientation and the relatively steep walls of *Paranthropus robustus* teeth imply predominantly vertical loading, whereas the enamel microstructure and substantive lateral buttress of *Australopithecus africanus* teeth suggest adaptation to laterally-directed loads. Since occlusal loads are dissipated into the jaw via the tooth roots, the splay of the maxillary molar roots is likely to reflect the amount of lateral excursion of the mandible during chewing. Here we employed landmark-based geometric morphometrics on CT-based 3D reconstructions of maxillary first molar roots of South African Plio-Pleistocene hominins from Sterkfontein, Swartkrans and Kromdraai. Comparisons were made with chimpanzees, i.e., a soft fruit consumer with predominantly vertical loading, and gorillas, i.e., an eclectic feeder that shows considerable lateral

excursion of the mandible during mastication. Principal Component Analyses revealed that all hominins had roots that were bucco-palatally more expanded than those of the great apes, and their palatal and buccal roots were more evenly shaped. Hominins from Sterkfontein showed marked, bucco-lingual splayed and robust tooth roots. Conversely, the sample from Swartkrans/Kromdraai, traditionally assigned to *P. robustus*, exhibits upright, more evenly-shaped buccal and palatal roots. These results support propositions that *A. africanus* and *P. robustus* probably had different dietary ecologies. However, the great variation found among Sterkfontein hominins highlights the heterogenous nature of this sample. Importantly, our analyses revealed morphological clusters within this sample, perhaps indicative that more than one taxon may be represented in this assemblage.

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### Calcar Femorale Development in *Orrorin tugenensis* Femora Provides Further internal Evidence for Bipedal Locomotion

ADAM J. KUPERAVAGE<sup>1</sup>, SAKDAPONG CHAVANAVES<sup>2</sup> and ROBERT ECKHARDT<sup>2</sup>

<sup>1</sup>Department of Public and Allied Health Sciences, Delaware State University, <sup>2</sup>Department of Kinesiology, Penn State University

The calcar femorale (CF) is a plate of dense bone internal to the lesser trochanter and continuing to approximately the mid-point of the medial femoral neck. This structure is visible in computerized tomographic (CT) images of the 6 million-year-old femoral fragments BAR 1002'00, and even more clearly in BAR 1003'00, both among the oldest specimens relevant to reconstructing the evolution of human bipedal locomotion. A strongly expressed CF has been suggested previously as an indicator of bipedality. If that proposition is correct, then there should be a quantifiable difference in the CF among hominoids that differ in extents of bipedal locomotion. While some attempts to quantify the size of the CF in humans have been reported, no such attempts have been made in apes. To test the hypothesis that degree of CF expression is related to bipedal locomotion, absolute and normalized CF lengths were measured from CT images at five locations along the proximal portion of BAR 1003'00 in addition to samples of 9 extant human and 10 chimpanzee femora. The BAR 1003'00 CF falls in the human range for both absolute and normalized CF. The human sample exhibited CF lengths that were consistently longer at each location than for chimpanzees in absolute terms. Normalized lengths for humans were larger than for chimpanzees but overlapped more substantially. Chimpanzee femora were more variable both in the occurrence of the structure and, where present, its

length. In BAR 1003'00, degree of CF expression ranges from more human-like proximally to less human-like distally.

### A 3D geometric morphometric study of the ilium during growth and the influence of habitual activity in the Later Stone Age foragers of southern Africa

HELEN KURKI<sup>1</sup> and LESLEY HARRINGTON<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Victoria, <sup>2</sup>Department of Anthropology, University of Alberta

High levels of within-population size and shape variation in the human adult pelvis suggest that this structure is more biologically plastic than previously thought. The adult pelvis is the product of the skeletal growth process, and as such, use of the lower limb in locomotion during the growth period may influence the shape of the developing pelvis. Variation among individuals in the levels of mobility may contribute to pelvic variation. This study examines the pattern of shape change in the ilium in a sample of juveniles (N=54) from the Later Stone Age foragers of southern Africa (mid-Holocene) using three-dimensional geometric morphometrics, and assesses the relationship of ilium shape change through ontogeny with femoral midshaft robusticity (J) as an indicator of mobility. Principal components analysis of twelve 3D landmarks of the ilium summarized shape variation in the sample. Four of the first five PCs (PCs 1, 2, 4 and 5) show significant relationships with estimated age at death, capturing shape change through ontogeny. Age-adjusted values of PCs 1-5 were regressed on size-standardized femoral midshaft J values. None of these relationships were significant, suggesting that activity levels do not significantly influence overall shape variation in the ilium through ontogeny. It is possible that robusticity variation is too low in this highly active forager population to produce detectable variation in ilium shape, or that biomechanical influences on ilium shape during growth are too subtle to be detected in an analysis of whole-ilium shape.

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### A Bioarchaeological Investigation of Marine Resource Procurement among the Chumash of Santa Rosa Island, California

SUSAN C. KUZMINSKY<sup>1</sup>, JON M. ERLANDSON<sup>2</sup> and TATIANA XIFARA<sup>3</sup>

<sup>1</sup>Instituto de Arqueología y Antropología, Universidad Católica del Norte, <sup>2</sup>Department of Anthropology, University of Oregon, <sup>3</sup>Department of Biology, Colorado State University

Archaeological investigations on California's Channel Islands have revealed that between ~8000 and 3000 years ago there was an intense exploitation of red abalone (*Haliotis rufescens*).

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Red abalones were an important food source during this period, but it is unclear how they were harvested. Using ecological data on sea surface temperatures and abalone habitats, some researchers have argued that red abalones were collected in subtidal waters, requiring people to free-dive for these mollusks, while others have argued that people waded through the shallow intertidal for them. We hypothesized that if people were free-diving for red abalone, then we should find evidence of external auditory exostoses (benign bony ear growths) among prehistoric northern Island Chumash populations. To better understand this food procurement activity, we analyzed a skeletal series of 207 individuals from Santa Rosa, which is the second largest island of the northern Channel Island chain. The presence, absence, number, and degree of severity of growths were recorded for the skeletal series spanning 7,000 years of prehistory. Results showed that approximately 11% of the population had exostoses, with 22.5% of males and 3.4% of females affected. These results are far lower than the percentage of exostoses reported for the southern Channel Islands and other sites along the Pacific Coast, which suggests that red abalones were most likely collected in the shallow intertidal waters of Santa Rosa Island. This study offers new insights into the cultural ecology of prehistoric Island Chumash populations who inhabited the northern Channel Islands.

### Estimation of individual body mass from the femur: insights from a CT-based analysis of body composition

ALIZÉ LACOSTE JEANSON<sup>1</sup>, JÁN DUPEJ<sup>1,2</sup> and JAROSLAV BRŮŽEK<sup>1,3</sup>

<sup>1</sup>Laboratory of 3D Imaging and Analytical Methods, Department of Anthropology and Human Genetics, Faculty of Natural Science, Charles University, Prague, Czech Republic, <sup>2</sup>Department of Software and Computer Science Education, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic, <sup>3</sup>PACEA – UMR 5199, CNRS, Université de Bordeaux, Talence, France

Body mass (BM) estimation methods from the femur provide adequate results for inter-population comparisons but have not been designed, nor provide reliable information for the purpose of studying inter-individual variability, which is influenced by fat (FM) and fat-free masses (FFM). Hence, our study aimed to evaluate the co-variation of body composition and the femur.

We analyzed a Czech sample of adult lower limb CT scans (44 males, 19 females). We evaluated the correlation of estimated FM, %FM and FFM with external dimensions, diaphyseal cortical area (CA) in every direction and position along the diaphysis and medial axis curvature of the femur.

Femoral articular dimensions, typically used to predict inter-population BM, correlate with FFM in males, but not FM or %FM in either sex. CA at

specific locations correlates well with FM and %FM in females only ( $R^2 \geq .6$ ). CA correlation with FFM is lower than with FM and weaker in males compared to females. Robustness significantly correlates with FM, FFM and %BF in females and exclusively with FFM in males. Femoral curvature is the only predictor that significantly correlates for both sexes with %FM and FM but not FFM.

The femoral diaphysis seems to get thicker, straighter, and more robust with the increasing of FM or %FM in females while it solely reduces curvature in males. In contrast, a FFM increase correlates with femoral articular dimensions in males and with robustness in both sexes. Further research is needed to confirm the results on a sample of whole-body CT scans.

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### Evidence for Subsistence Shifts in the Late Upper Paleolithic of Europe: Caries and Antemortem Tooth Loss

SARAH A. LACY

Department of Anthropology and Archaeology, University of Missouri-St. Louis

The Late Upper Paleolithic of Western Eurasia is characterized by human groups expanding geographically where climatically possible and increasing in density; however, despite the resilience suggested by this population growth, extreme climatic instability would be physiologically stressful and require adaptive dietary shifts. These diet changes can be identified via the prevalence of two oral pathologies: caries and antemortem tooth loss. Comparing Early Upper Paleolithic to Late Upper Paleolithic individuals (N=124) along with published Mesolithic and Neolithic values for Europe and Southwest Asia, the oral pathology prevalences of the Late Upper Paleolithic can be contextualized. Late Upper Paleolithic peoples show increased caries prevalence relative to the preceding period perhaps reflecting a move towards carbohydrates from fats as the nutritional supplement to dealing with the negative aspects of a high protein diet. Increasing food resource pressures and a focus on smaller game would necessitate this adaptive response as well as reflect shifting climatic ecozones. The caries examples tend to cluster further south where environmental sugars are more readily available, but this is the earliest period in which caries appear further north of the circum-Mediterranean region. Tooth loss prevalence also increases (by either percent of teeth overall or by individual affected), perhaps indicating changes in food preparation, but also improved cultural buffering to the effects of tooth loss on health and quality of life. These trajectories of increasing caries and antemortem tooth

loss generally continue into the Mesolithic and suggest that major dietary changes were initiated as early as the Late Upper Paleolithic.

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### Variation in osteon size in the cercopithecoid femur and its implications for bone fracture toughness

SUSAN E. LAD<sup>1</sup>, W. SCOTT MCGRAW<sup>2</sup> and DAVID J. DAEGLING<sup>1</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Anthropology, The Ohio State University

Osteonal bone, while weaker than primary bone, is thought to enhance resistance to fracture by preventing the spread of cracks. It has been proposed that large osteons or combinations of small but densely packed osteons can increase fracture resistance. In this exploratory study osteon area (OA) was measured from femoral thin sections of four cercopithecoid species: *Cercocebus atys* and *Cercopithecus diana* (Cercopithecinae), *Colobus polykomos* and *Ptilocolobus badius* (Colobinae). A hierarchical ANOVA was used to investigate subfamily and species (nested within subfamily) differences in OA. Subfamily affiliation was not a significant source of variance but species membership was ( $P=0.006$ ). This finding was driven by the difference between *C. diana* (mean OA=0.020 mm<sup>2</sup>) and *C. atys* (mean OA=0.018mm<sup>2</sup>). Colobine mean OA is intermediate (0.019mm<sup>2</sup> for both). All species have relatively lower OA than what is reported in the literature for humans (0.028-0.045mm<sup>2</sup>) and chimpanzees (0.028-0.033mm<sup>2</sup>). Interestingly, Moyle and Bowden (J. Biomech 17:203-213) found that femoral osteons with diameters <170µm or >200µm require greater work to fracture than those intermediate in size. Our cercopithecoid osteon diameters fall below the lower threshold, while humans and chimpanzees fall above, or just below, the higher threshold. This suggests that monkeys and apes may have different strategies for resisting bone fracture with respect to secondary bone formation.

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### Refining a Traditional Method in Dental Wear Analysis for Greater Application

EMMA M. LAGAN

Anthropology, Ohio State University

Teeth directly interact with an individual's environment and do not remodel over time, which makes dental wear an ideal focus for studying life-style differences. Previous studies have analyzed dental enamel wear on a quadrant-by-quadrant basis using a 0-10 scale beginning with the first sign of worn enamel. This method assigns an ordinal score that can reflect overlapping ranges of dental wear patterns, making it difficult to

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directly compare specimens. The purpose of this study was to refine the method to emphasize dentine exposed rather than enamel lost. The revised method uses a 0-6 scale beginning with exposure of dentine. Removing values associated with wear before dentine exposure generated a more precise total score than its predecessor, allowing the specimen to be ranked, and therefore compared, with greater accuracy.

Continual development of this method generates possibilities for future research in dental wear analysis. Scores can be used to examine rate or degree of wear in an individual. Additionally, the score can be divided by the maximum sum (24) to reflect the percentage of dentine exposed. Previously, this required the use of a specialized computer program. A test sample (n=61) comparing the revised method and the computer analysis showed the difference in results to be insignificant ( $t=-0.831$ ,  $p = 0.408$ ), meaning the specialized computer analysis is no longer required. This modification creates new opportunities in intra-population (status, sex, age) and inter-population (rural vs. urban, regional, religious) analyses, especially in pre-Industrial populations when a less refined diet led to greater overall dental wear.

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### DNH 32: A distal humerus of *Paranthropus robustus* from Drimolen, South Africa

MICHAEL R. LAGUE<sup>1</sup> and COLIN G. MENTER<sup>2</sup>

<sup>1</sup>School of Natural Sciences and Mathematics, Stockton University, <sup>2</sup>Centre for Anthropological Research (CFAR), University of Johannesburg, South Africa

The Main Quarry deposits at the Early Pleistocene fossil site of Drimolen, South Africa, preserve hominin craniodental remains attributed to *Paranthropus robustus* and an unidentified species of early *Homo*. Hominin postcranial specimens from the site are less common and few have been identified to taxon. During excavations in the 1990s, an unidentified hominin distal humerus fragment (DNH 32) was recovered that preserves most of the elbow joint and a short portion of diaphysis. In this study, we examine the morphology of DNH 32 to assess whether it can be confidently attributed to (or excluded from) any particular hominin species (*P. robustus*, *H. habilis*, *H. erectus*). Multivariate ordination techniques are applied to landmark data from two anatomical regions (distal diaphysis, elbow joint) to quantitatively compare DNH 32 to other Early Pleistocene fossil humeri. Distance metrics reflecting shape dissimilarity between DNH 32 and the other fossils are assessed in the context of intraspecific variation within modern hominid species. Our comparisons indicate that DNH 32 has the same distinctive elbow morphology observed among virtually all Plio-Pleistocene fossil hominins. Based on diaphyseal shape, however, DNH 32 has a low probability of belonging to early

*Homo*, and a high probability of belonging to *P. robustus*. We conclude that DNH 32 belongs to *P. robustus* and is therefore the only long bone at Drimolen attributed to an adult of that species. It is also one of only three fossil humeri from South Africa now allocated to *P. robustus*.

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### Dynamic chewing: A novel approach to analyzing three-dimensional motion sequences

MYRA F. LAIRD<sup>1</sup> and PAUL O'HIGGINS<sup>2</sup>

<sup>1</sup>Department of Organismal Biology and Anatomy, University of Chicago, <sup>2</sup>Centre for Anatomical and Human Sciences, Department of Archaeology and Hull York Medical School, University of York

Here we present a new method of analyzing three-dimensional movements of markers placed on the face during chewing. This method addresses issues in analyzing rhythmic motions of markers whose coordinates are captured as a series of sequential 'frames'. We applied the method to gape cycles from human subjects chewing cooked and raw sweet potato. We hypothesized that gape cycles for raw sweet potato will be differentiable from cooked sweet potato, and that the first few gape cycles will differ from the rest of the sequence.

Six markers were placed on eight subjects: three on the upper face and three on the jaw. Their three-dimensional coordinates were captured at 200 frames per second using a Vicon system. Landmarks from each chewing sequence were divided into individual gape cycles and standardized to 99 frames. The sequence of coordinates from the frames within each cycle were combined into a single configuration of landmarks describing the whole gape cycle. This comprises the three upper face 'fixed' landmarks plus the three jaw markers from each of the 99 frames, 300 landmarks in all. The resulting configurations were subjected to principal components analysis to compare cooked and raw sweet potato gape cycles. Gape cycles for raw sweet potato were distinguishable from cooked sweet potato. The first few cycles were more variable than those in the rest of the sequence. These results are consistent with previous analyses of gape cycle kinematic variation. This method offers a new approach of analyzing three-dimensional movement data applicable to anthropological analyses.

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### *Propithecus* as Prey: vigilance and Behavioral Changes in *Propithecus edwardsi* After a Perceived Predator Threat

ALICIA R. LAMB<sup>1</sup> and PATRICIA WRIGHT<sup>2</sup>

<sup>1</sup>Department of Ecology and Evolution, Stony Brook University, <sup>2</sup>Department of Anthropology, Stony Brook University

Vigilance behavior is hypothesized to affect the time an animal can devote to other essential daily activities; thus, the perception of increased predator risk may impact the fitness and health of individuals. To explore the relationship between vigilance behavior and activity budgeting, we collected data on 7 groups of Milne-Edwards' sifaka (*Propithecus edwardsi*) across a range of pristine to selectively-logged forest in Ranomafana National Park in southeastern Madagascar from June-August 2016 (n = 600 hours). To simulate the presence of a perceived natural stressor, we played recorded predator calls of Henst's goshawk and documented individual behavior pre- and post-playback. Sifakas significantly increased the time spent in vigilance behavior after the predator playback, indicating a perception of predator risk (chi square:  $p$ -value=0.0150). Additionally, individuals spent significantly more time travelling following predator playbacks ( $p = 0.0443$ ). Interestingly, there was no significant difference in the proportion of time spent feeding before and after playback calls ( $p = 0.2415$ ), suggesting that feeding time in *P. edwardsi* may be prioritized despite increases in other behaviors, such as vigilance and travelling. There was also a statistically significant decrease in the proportion of time sifakas spent resting ( $p = 0.0127$ ) and grooming ( $p = 0.0028$ ). These data suggest that *P. edwardsi* populations that perceive an increased risk of predation, reallocate the time devoted to some activities to accommodate the increased perceived need for vigilance. It is therefore possible that anthropogenic stressors such as ecotourism and forest degradation may impact activity allocation which could impact the overall health of sifaka populations.

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### Treponematoses in indigenous North America: Bioarchaeological perspectives on the epidemiological landscape of a spirochete disease

PATRICIA M. LAMBERT

Anthropology Program, Utah State University

Treponematoses has a long and varied history in native North America. The prehistoric presence and epidemiology of the disease is known primarily from bioarchaeological research on human skeletal remains from archaeological sites in the U.S., studies that tend to support a model

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of a non-venereal form of the disease prevailing before European contact. While much attention has focused on the origins of venereal syphilis and its relation to New World treponemes, less is known about possible variation in the non-venereal, endemic form (or forms) of the disease that affected people across the continent prehistorically. The purpose of this paper is to examine the osteological characteristics of treponemal disease in prehistoric human remains from two major climate zones, the dry, semi-arid West (southern California, the Southwest, and the Great Basin) and the humid, subtropical Southeast (North Carolina and Virginia)—that based on modern clinical research might be expected to manifest or support different endemic forms of treponematosi: endemic syphilis and yaws respectively. Preliminary results suggest that treponemal disease in human remains from the Southeast may indeed conform to a more yaws-like pattern, whereas a less prolific osteological response in human remains from the West may better fit the disease profile for endemic syphilis.

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### Group Augmentation explains Territorial Boundary Patrolling by Male Chimpanzees at Ngogo

KEVIN E. LANGERGRABER<sup>1</sup>, DAVID P. WATTS<sup>2</sup>, LINDA VIGILANT<sup>3</sup> and JOHN C. MITANI<sup>4</sup>

<sup>1</sup>School of Human Evolution and Social Change and Institute of Human Origins, Arizona State University,

<sup>2</sup>Department of Anthropology, Yale University,

<sup>3</sup>Primate Department, Max Planck Institute for Evolutionary Anthropology, <sup>4</sup>Department of Anthropology, University of Michigan

Chimpanzee (*Pan troglodytes*) territoriality is distinguished by "patrols" in which males move along territory boundaries, often intrude into neighboring territories, and sometimes attack neighbors; attacks can be lethal. Numerical superiority reduces the risks of aggression, but patrols are never risk free and they entail energetic and opportunity costs. This raises questions of whether they pose collective action problems. Collective action can be difficult to achieve because the fitness of "free-riders" can exceed that of cooperators, especially in large groups. We used data on 284 patrols by members of the unusually large Ngogo chimpanzee community, collected over 20 years, to examine whether variation in short-term benefits and costs explained variation in male participation, as expected if patrolling presents a collective action problem. Some results were consistent with this hypothesis: patrol participation varied positively with male paternity success and rank, and individuals were less likely to patrol when community size was larger. However, participation did not depend

on how many maternal relatives males had at the times of patrols and males with no offspring often patrolled. Overall patrolling effort did not decrease as community size increased. In this large community, male reproductive skew is low and many males who patrolled when they had no offspring, reproduced later. We suggest that group augmentation theory explains these results better than collective action theory: males cooperate in territorial defense because this enhances community size, which in turn increases success in competition with other communities and male fitness.

### Assessing the role of migration during a cultural transition (fourth century BC to AD sixth century): Strontium isotope results from Samtavro cemetery, Central Georgia

NATALIE LANGOWSKI<sup>1</sup>, VARSHA PILBROW<sup>1</sup> and ROLAND MAAS<sup>2</sup>

<sup>1</sup>Department of Anatomy and Neuroscience, University of Melbourne, <sup>2</sup>School of Earth Sciences, University of Melbourne

The remarkable Samtavro cemetery in Mtskheta, Central Georgia, yields evidence of local cultural interaction with Sassanid, Greek and Roman civilizations. The cemetery was used heavily during the Iberian Kingdom (4th century BC-AD 6th century) and records a cultural transition from tile-lined burials containing single articulated skeletons to stone-cist burials containing disarticulated remains of multiple individuals. Individuals with artificially modified crania found in cist tombs suggest a novel cultural influence introduced via an influx of migrants.

To investigate the possible presence of non-local individuals in Mtskheta, <sup>87</sup>Sr/<sup>86</sup>Sr ratios were measured in tooth enamel of 11 humans, including eight from stone cists (three with modified crania), and three from tile-lined burials. These results are compared with the local bioavailable <sup>87</sup>Sr/<sup>86</sup>Sr signature established from 14 archaeological faunal samples and published bioavailable strontium data from East Transcaucasia.

<sup>87</sup>Sr/<sup>86</sup>Sr in faunal ( $\bar{x} \pm \sigma$ ) = 0.70781 ± 0.00028, 1σ) and human samples ( $\bar{x} \pm \sigma$ ) = 0.70785 ± 0.00025, 1σ) shows little variation, consistent with a majority of the samples originating within Mtskheta or the wider East Transcaucasian region. Likewise, <sup>87</sup>Sr/<sup>86</sup>Sr in enamel samples from individuals associated with the two burial types, or from individuals with modified and non-modified crania, show no significant difference (Mann-Whitney,  $p > 0.05$ ). However, five samples (one individual from a tile-lined burial, one with a modified cranium, and three ovicaprids) exhibit <sup>87</sup>Sr/<sup>86</sup>Sr ratios outside the local range. Although further data for local bioavailable strontium are needed, this study supports a minor role for migrants in the Iberian period transition at Samtavro.

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### Cementochronology and Palaeodemography: A New Method to Assess the Probable Age Distribution of Immatures

LAËTITIA LANTER<sup>1</sup>, BÉRENGÈRE SALIBA-SERRE<sup>1</sup>, BRUNO BIZOT<sup>1,2</sup>, JEAN GAUDART<sup>3</sup>, MICHEL SIGNOLI<sup>1</sup> and AURORE SCHMITT<sup>1</sup>

<sup>1</sup>UMR 7268 ADES Anthropologie bio-culturelle, Droit, Ethique et Santé, Aix-Marseille Université – CNRS – EFS, <sup>2</sup>Service Régional de l'Archéologie PACA, Ministère de la Culture et de la Communication, <sup>3</sup>UMR 912 SESSTIM, Aix-Marseille Université – IRD – INSERM

Standard individual age estimators have been reported to be too imprecise to reconstruct valid paleodemographic mortality profiles, due to methodological biases. Although the debate is mainly centered around adults, subadult estimated age intervals overlapping two demographic age categories remain an unresolved issue.

Cementochronology is traditionally applied to adults since standard subadult estimators are considered sufficiently precise. The implementation of different aging methods is thus necessary to aggregate subadults and adults in order to reconstruct complete mortality profiles. However, this approach introduces biases of the same nature since subadults overlapping two demographic age groups are also common. The recent application of cementochronology, combined with probability density analysis, provided an initial solution by calculating precise adults individual age-at-death and mortality profiles.

This study expands this approach by assessing the age-at-death distribution of 42 subadults from the cathedral Notre-Dame-du-Bourg (16th-18th centuries, France), using cementochronology and probability density analysis. The goal is to test a single age indicator on a sample of deciduous and permanent teeth to minimize the biases across age categories.

Results revealed that the "0-1" age category was underestimated when compared to the "archaic mortality pattern" but consistent with historical records, especially in a cathedral where non-baptized newborns were excluded. However, cementochronology slightly overestimated the "15-19" age category compared to historical records in a nonsignificant way given the small sample size of this age category.

Cementochronology is thus the only method that can reconstruct paleodemographic mortality profiles by including subadults and adults individual age estimates from a single skeletal collection.

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### An Evolutionary Perspective on the Contribution of Serotonergic Genetics to Health: Lessons from Rhesus Macaques

SAM M. LARSON<sup>1</sup>, ANGELINA RUIZ-LAMBIDES<sup>2</sup>, JULIE HORVATH<sup>3</sup>, ATHY ROBINSON<sup>4</sup>, PATE SKENE<sup>4</sup>, MICHAEL L. PLATT<sup>5,6,7</sup> and LAUREN J.N. BRENT<sup>8</sup>

<sup>1</sup>Department of Anthropology, University of Pennsylvania, <sup>2</sup>Caribbean Primate Research Center, University of Puerto Rico, <sup>3</sup>Biological & Biomedical Sciences, North Carolina Central University, <sup>4</sup>Department of Neurobiology, Duke University, <sup>5</sup>Department of Neuroscience, Perelman School of Medicine, University of Pennsylvania, <sup>6</sup>Marketing Department, The Wharton School, University of Pennsylvania, <sup>7</sup>Department of Psychology, University of Pennsylvania, <sup>8</sup>Centre for Research in Animal Behaviour, University of Exeter

Genomic variation related to serotonin biosynthesis can serve as risk factor for psychopathology, particularly when following early-life stress. Recent evolutionary informed theory posits that this relationship, rather than uniformly maladaptive, may be advantageous given certain social contexts. Here, we examine mortality trajectories according to serotonergic genotype in a free-ranging nonhuman primate (*Macaca mulatta*). We fit life-tables to subjects genotyped for VNTR length polymorphisms—short (S) vs. long (L)—of two serotonergic genes (5-HTT and TPH2). Females carrying at least one copy of the less frequent 5-HTT<sub>(S)</sub> and TPH2<sub>(L)</sub> alleles had greater mortality rates in early life but slower rates of senescence, and thus ultimately lived longer than females homozygous for 5-HTT<sub>(L)</sub> or TPH2<sub>(S)</sub> respectively. For 5-HTT, an opposite pattern is observed in males, where those carrying at least one copy of the 5-HTT<sub>(S)</sub> have shorter lifespans than homozygous 5-HTT<sub>(L)</sub> males. Males TPH2<sub>(S)</sub> homozygotes, like the females, have a reduced life expectancy than those carrying a copy of TPH2<sub>(L)</sub>. Our results are consistent with the hypothesis that poor functioning of the serotonergic system results in increased sensitivity to the social environment, which may better serve female macaques than male. We discuss our findings in light of widely reported sex differences in sensitivity to stress, development of psychopathologies, and resilience in the context of social support, especially as mediated by serotonergic genetics. As mortality is a major component of fitness, this study offers some resolution to the question of the persistence of serotonergic allelic variation in human evolution.

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### The role of experimental approaches to the interpretation of form-function relationships in the fossil record

SUSAN G. LARSON

Anatomical Sciences, Stony Brook University School of Medicine

Following the announcement of a new fossil discovery, its morphology is typically compared to that of other fossils and to samples of extant taxa to both determine its phylogenetic affinities and reconstruct something about its behavior and lifestyle. The latter depends on observed correlations between morphology and behavior that serve as a basis for hypotheses of form/function relationships, frequently in the form of biomechanical models that make predictions for further testing. Most commonly these predictions are tested by making additional morphological or behavior observations, but no matter how strong the correlation or how logical the model, establishing a causal form/function relationship ultimately depends on the demonstration that the structure in question does indeed contribute to the performance of the behavior. Empirical testing of form/function links has traditionally been done in a controlled laboratory setting, but for a variety of reasons, the use of experimental methods has never been widely embraced in the field of biological anthropology. Nonetheless, examples such as the demonstration that the primate peroneus longus is not used to adduct the hallux during grasping contrary to the well-accepted interpretation of peroneal process size, illustrate why this step in the functional analysis of morphology should not be neglected. Despite its critical role in paleoanthropology, lab-based research by biological anthropologists is jeopardized by efforts of animal rights activists directed at the biomedical research community to curtail access to primate subjects. Though once a novelty, field and zoo based methods for testing functional hypotheses may become our only option.

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### Impact of Behavioral Traits on Diversification Rates in Primates

ALEJANDRO LASERNA<sup>1</sup> and JAMES P. HERRERA<sup>2</sup>

<sup>1</sup>Department of Anthropology, Queens College, City University of New York, <sup>2</sup>Department of Mammalogy and Division of Vertebrate Paleontology, American Museum of Natural History

Diversification rates can be affected by certain traits, such as key innovations which allow organisms to exploit open niches. Primates have flexible behaviors in response to the environment, possibly reflecting adaptations. Changes in these traits may affect diversification rates. While research has been done on the evolution of molecular and morphological characters, little is known about behavioral evolution. Previous studies

have attempted to use behavioral characters to test for phylogenetic signal, finding evidence of homoplasy. Traits exhibiting homoplasy may be adaptive, and therefore may effect diversification rates. We tested if nine behavioral traits were related to diversification using state dependent speciation and extinction analyses (n=80-110 species per trait). Dispersal showed no effect on speciation rates (likelihood ratio test, p>0.05); net diversification rates were near zero for lineages in which male and female dispersal was common or uncommon. Allomothering showed a positive effect on speciation - species that have allomothering had higher speciation rates (0.93 species My<sup>-1</sup>) than those that did not (0.22 species My<sup>-1</sup>). Mating system also showed a positive effect on speciation. This may be explained by potentially higher genetic diversity in primates that mate promiscuously than in species that mate monogamously, which may lead to more chances for evolution to take place. While dispersal patterns had no effect on diversification, infant care and mating systems did, indicating that these traits may be adaptive. Further research is needed to understand the proximal links between traits and fitness that may lead to effects on diversification rates.

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### Does the shape of the talus predict first metatarsal abduction?

STEVEN G. LAUTZENHEISER<sup>1,2</sup>, ADAM D. SYLVESTER<sup>3</sup> and PATRICIA A. KRAMER<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Washington, <sup>2</sup>Department of Orthopaedics and Sports Medicine, University of Washington, <sup>3</sup>Center for Functional Anatomy and Evolution, The Johns Hopkins University School of Medicine

The foot of *Homo sapiens* is unique among the extant primates because it does not have an abducted first metatarsal. Given that the talus is the only bony attachment between the leg and the foot and that the talus links the lateral and medial columns of the foot, greater divergence of the first metatarsal could begin in the talus. Thus, we hypothesize that the shape of the talus is correlated with the degree of first metatarsal abduction.

Angular measurements of 25 randomly selected people from the database of a Level 1 trauma center were made using their weight-bearing radiographs and their simulated weight-bearing computed tomography (SWCT) scans. Mean navicular height on weight bearing radiographs is similar to that obtained from the SWCT scans (7.17cm vs 7.13cm; p = 0.44), indicating that the SWCT simulation recreates the weight-bearing position of the bones of the foot. Linear regression was used to determine the ability of three angles of the talus (talar neck, medial and lateral trochlear edges) to predict the abduction of the

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first metatarsal (angle between the first and second metatarsals shafts).

None of the talar angles were predictive of the first metatarsal abduction angle (all  $p$ -values > 0.05). Our three metrics indicate that the abduction angle of the first metatarsal is not influenced by the shape of the talus, suggesting that first metatarsal divergence is a feature of the distal mid-foot. The shape of the talus may, then, be determined by the force distribution from the leg to the foot.

### Brain Proportions in Early Anthropoid Evolution: Evidence from the Fayum Fossil Record

RICHA LAVINGIA<sup>1</sup> and KARI L. ALLEN<sup>2</sup>

<sup>1</sup>Medical Student, Baylor College of Medicine,

<sup>2</sup>Neuroscience, Washington University School of Medicine

The Oligocene deposits of the Fayum Depression of Egypt provide our earliest evidence for the anthropoid brain. Previous analyses of virtual endocasts from *Parapithecus* (DPC 18651) and *Aegyptopithecus* (CGM 85785, CGM 40237) demonstrate that these species shared key features of endocast shape with extant haplorhines, at a brain volume more akin to that of extant strepsirrhines. We introduce a new method for “virtual dissection” of the endocast to estimate the relative proportion of brain components in these well preserved fossil specimens.

Endocasts were constructed from CT scans of 33 extant primate genera. Endocranial surface landmarks were used to delineate the posterior cranial fossa (PCF) and olfactory fossa (OF) from the rest of endocast (ROE), and these components served as proxies for cerebellum, olfactory bulb, and “rest of brain” volume, respectively. Residual volumes were calculated from PGLS regressions with ECV as  $x$ -variable. As predicted from analyses of corresponding brain components, extant haplorhines have significantly ( $p < 0.0001$ ) lower mean resPCF and resOF volume, and greater resROE. A principal components analysis (PCA) of residual endocast components shows clear separation between primate suborders (PC1: 89% of variation). Crucially, the Fayum specimens cluster with the extant haplorrhines.

The proposed method provides a valid means of timing changes in brain proportions throughout geological time and will allow researchers to include fossil data into future comparative analyses of brain evolution. Our analysis bolsters previous evidence that *Parapithecus* and *Aegyptopithecus* achieved brain proportions similar to those of extant haplorhines, despite being significantly less encephalized than modern forms.

### A novel approach to anatomical complexity: Random Forest Analysis applied to jaw morphology in Homininae

JULIE LAWRENCE<sup>1</sup> and MÁRTON SÓSKUTHY<sup>2</sup>

<sup>1</sup>Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Language and Linguistic Science, University of York

Random Forest (RF) Analysis is a classificatory technique that has been employed by the life and social sciences for over 10 years, but it has not previously been applied to morphological data. This paper highlights RF's potential for hominine comparative anatomy with a view to contextualise fossil hominins. Which linear variables are more effective at diagnosing specimens of known taxa and sex, are the same variables effective across these groupings, and how do they relate to established diagnostic features of hominin taxa?

RF has strong prediction ability compared with the more frequently used Discriminant Function Analysis, but requires far fewer assumptions. RF is adept at handling complex and/or missing data, and is robust against overfitting. These attributes make RF ideal for use with fossil and comparative data, where, for a number of reasons, sample size may be low, and complex anatomical regions are often represented by a large number of variables.

To test RF's potential, we use it here with corroborating analytical techniques (including geometric morphometric methods) to explore intra- and interspecies morphological variation. Linear variables were calculated from 73 3D landmarks on the maxillae and mandibles of gorillas ( $N=33$ ), chimpanzees ( $N=30$ ), humans ( $N=52$ ) and australopiths ( $N=49$ ). Overall, mandibular P3 length is a particularly important discriminative feature. Mandibular canine length, diastema length and symphysis height also accurately classify taxa and sexes. Conversely, mandible height measurements contributed far less to the models. We discuss the advantages and shortcomings of this relatively easy-to-use technique for exploring morphometric data and the fossil record.

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### Diversity, Abundance, and Paleoecology of East African Suidae in the Context of Hominin Evolution During the Pliocene

IGNACIO A. LAZAGABASTER, JOSHUA R. ROBINSON, CHRISTOPHER J. CAMPISANO and KAYE E. REED

Institute of Human Origins and School of Human Evolution and Social Change, Arizona State University

Recent fossil discoveries have shown that East African hominin diversity during the Pliocene was much higher than previously thought, suggesting that different hominin taxa may have exploited a variety of food resources and/or habitats. Here,

we explore the role of environmental change in Pliocene hominin diversification by studying changes through time in suid lineages. Suidae are generalized omnivores, common in hominin fossil sites, and evolved quickly in response to climate change. We compiled diversity, abundance, and stable isotope data for Pliocene hominins and suids, from localities in the Afar region, the Ormo-Turkana Basin, and Laetoli. From 4.0 to 2.3 Ma, both diet and abundance of Suidae oscillates, indicating short-term fluctuations in habitat availability. In general, when suid diets have a higher C4 component, *Notochoerus* is more abundant, an opposite trend to that observed for *Kolpochoerus* and *Nyanzachoerus*, which probably preferred closed habitats and/or different diets. For example, *No. euilus* is very abundant ca. 3.4 Ma, and again ca. 3.2 Ma, a time coincident with the extinction of *Ny. kanamensis* and the beginning of a general decrease in suid abundance and an increase in hominin abundance. Suid species appearances between 3.4 and 2.6 Ma are associated, in general, with more open environments. The multiple lines of evidence for the evolution of Suidae indicate short-term habitat changes within the general trend towards the opening of the environment, and reveal that there were several ecological niches through this time that could also have been exploited by more than one hominin taxon.

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### Imaging cementum in primate deciduous teeth using synchrotron phase contrast micro-tomography

ADELINE LE CABEC<sup>1,2</sup>, MICHEL TOUSSAINT<sup>3</sup>, DAVID R. BEGUN<sup>4</sup>, PAUL TAFFOREAU<sup>2</sup> and CHRISTOPHER DEAN<sup>5</sup>

<sup>1</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, <sup>2</sup>Beamline ID 19, ESRF – The European Synchrotron, Grenoble, France, <sup>3</sup>Unaffiliated, Belgium, <sup>4</sup>Department of Anthropology, University of Toronto, Toronto, Ontario, Canada, <sup>5</sup>Department of Cell and Developmental Biology, University College London, London, United Kingdom

Cementum is the dental tissue that anchors the tooth to the alveolar bone and grows incrementally, thus thickening with age. Hypercementosis—overgrowth of cementum mainly at the apical root third—has been observed in Neanderthal teeth especially. Regular cementum formation relates to age while hypercementosis potentially reflects (non-)dietary adaptations. Hypercementosis has been interpreted as an adaptive response to heavy or frequent loads exerted on the anterior teeth in the context of the “teeth-as-tools” hypothesis. The vast majority of previous work has focused on the description of cementum in the permanent dentition. The deciduous dentition has been left unexplored not only because of its

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temporary nature, but also because these teeth are shed with resorbed roots when the permanent dentition emerges.

Here we present a non-destructive imaging of cementum in deciduous teeth of various primates using propagation phase contrast X-ray synchrotron micro-tomography. These juveniles of different dental developmental stages involve Neanderthals, Upper Paleolithic modern humans, chimpanzees, an orangutan, and the Miocene *Anapithecus hernyaki*. Two-dimensional virtual sections in the apical root third of these teeth illustrate the amount and distribution of cementum on the root surfaces. Three-dimensional models highlight the aspect of the root surface, and the accessory root canals running through the hypertrophic cementum in older individuals. Our results suggest this hypercementosis and its expression are linked to a dietary shift occurring after weaning. These non-destructive observations impact our interpretation of the diet and life history of these juveniles in relation with the pattern and timing of their dental development.

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### Visual Versus Algorithmic Pair-Matching in a Modern Filipino Population

AMANDA B. LEE<sup>1</sup>, JANA SANTOS<sup>2</sup>, NIKKI VESAGAS<sup>2</sup> and MATTHEW C. GO<sup>1</sup>

<sup>1</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>Archaeological Studies Program, University of the Philippines, Diliman

Byrd and Adams (2009) proposed visual pair-matching as a “reliable and accurate” method for sorting commingled human remains. This technique is common practice for forensic anthropologists estimating the number of individuals belonging to a commingled assemblage. Any possible improvements to this method have implications for streamlining medicolegal procedures and improving estimation of the most likely number of individuals.

This study aims to compare the reliability of visual pair-matching to an algorithmic pair-matching tool. As there is no standard operating procedure for visual pair-matching, the study uses characteristics outlined by Byrd and Adams (2009). The 26 test scenarios conducted in this study simulated two recovery rates (0.6 and 0.7) on two different elements, the humerus and the femur. For every trial, the actual number of individuals was set at numbers ranging from 10 to 50 individuals. One researcher set aside bones from a stochastically generated list and these skeletal elements were pair-matched by a separate researcher who did not know the generating conditions.

Results for the humerus showed more inaccuracies than those for the femur. For N=50 with

a recovery rate of 0.7, 72 femora were selected with 25 true pairs. The observer counted 20 pairs of which 18 were correctly paired. The same scenario for the humerus resulted in a success rate 7% less than that of the femur trial. These results are compared to a pair-matching method based on measuring multivariate asymmetry. An advantage of this latter approach is that it provides probability statements on proposed pairs.

### Patterns of Trauma and Violence among Nomadic Pastoralists at the Nileke Site (500-221 BCE), Northwestern Xinjiang Province, China

CHRISTINE LEE, ARIANA BELTRAN-BURGOS, MARGARITA ALVAREZ and ALEJANDRA TORRES  
Anthropology, California State University, Los Angeles

The Nileke cemetery site is located in the Junggar Basin between the Tianshan and Altai mountain ranges. This region connects the steppe grasslands of Kazakhstan and Mongolia with the oasis states of the Tarim Basin. They were nomadic pastoralists, possibly related to the Pazyryk culture. A total of 46 individuals were analyzed (18 females, 27 males, and 1 indeterminate) for cranial trauma. Twenty percent of the crania had some evidence of trauma (9/46). Seven males and two females had cranial trauma. One female had suffered a blow to the left eye orbit and one female had a broken right zygomatic bone. Both of these injuries are consistent with interpersonal violence. Two males also showed evidence of interpersonal fighting. Both males had broken noses. Five males showed injuries consistent with the use of weaponry. Two individuals had sword cuts to the left parietal and the nose. Two men had healed blunt force or low velocity projectile wounds to the frontal and parietals. One male had a keyhole shaped wound on the left parietal from being grazed by a high velocity projectile. One male had a penetrating wound from a metal weapon on the right parietal. This individual also had evidence of trepanation to treat the wound. The pattern and location of the majority of these injuries suggest that the attackers were on horseback while those injured were on the ground. The trauma pattern and frequencies at Nileke are similar to other regional nomadic pastoralist sites and different from agriculturalist sites.

### How social justice perspectives expose hidden exclusions in science

DANIELLE N. LEE<sup>1</sup> and KATHRYN BH. CLANCY<sup>2</sup>

<sup>1</sup>Biological Sciences, Southern Illinois University Edwardsville, <sup>2</sup>Anthropology, University of Illinois

Science is defined as the systematic study of the physical and natural world through observation and experiment. Despite the insistence that science is an objective pursuit – and by extension, so are individual scientists – science, like

other human endeavors demonstrates considerable disparity and marginalization of opportunity. In academic scenarios, differential parity and enfranchisement is often assigned according to socioeconomic status, professional status, professional affiliation, and among international research partnerships – national residency. When researchers from more privileged institutions or nations embark on research projects in developing nations or with disenfranchised communities, there is risk of them unintentionally exploiting these power differentials. This can lead to excluding individuals and erasing input of under-represented groups from the scientific process. Our project interviews American trained scientists who study in developing nations. Our objective is to understand how implicit bias and conservative science funding influence project design and execution, as well as expenditure, training, and support decisions in service of data collection. We aim to demonstrate how social justice perspectives can expose unrealized moments of exclusion in science. By cultivating social justice activist mindset in science, we believe it improves the quality of our work and enriches the fields of science overall. It also can drive broadening participation in the sciences and invigorate intellectual promotion and economic stability of disenfranchised communities and developing nations.

### Origins of yeast domestication, as revealed from wine

JEAN-LUC LEGRAS  
UMR Sciences pour l'Oenologie, INRA

The diversity of alcoholic fermented beverages developed by Man around the world is a remarkable outcome of history. All of these fermented beverages rely on the same unicellular fungi: *Saccharomyces cerevisiae*, man's favorite fungi. Man shaped the diversity of this yeast species. Strains associated with wine were spread by man all over the world following a pattern reflecting history. The same story also unfolded with beer and cheese strains. The strains isolated from these different fermented products have gained traits reflecting the constraints imposed by natural or artificial selection in these anthropogenic ecological niches. The improvement of various traits and even the acquisition of new ones have been achieved through different mechanism: mutation, hybridization with other yeast species or horizontal gene transfer from other yeast genera, and left specific signatures in their genomes leading to modern domesticated lineages. However detangling natural and artificial selection in wine yeast remains one of the most challenging questions today.

# ABSTRACTS

## Exploring the Utility of Carbon Isotope Analyses of Small Mammal Tooth Enamel as an Environmental Proxy

JENNIFER N. LEICHLITER<sup>1</sup>, PAUL SANDBERG<sup>2</sup>, MATT J. SPONHEIMER<sup>1</sup>, BEN PASSEY<sup>3</sup>, NICO AVENANT<sup>4,5</sup>, OLIVER PAINE<sup>1</sup>, DARYL CODRON<sup>5,6</sup> and JACQUELINE CODRON<sup>7</sup>

<sup>1</sup>Department of Anthropology, University of Colorado at Boulder, USA, <sup>2</sup>Archaeology Division, Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, USA, <sup>3</sup>Department of Earth and Planetary Sciences, Johns Hopkins University, USA, <sup>4</sup>Department of Mammalogy, National Museum, Bloemfontein, RSA, <sup>5</sup>Centre for Environmental Management, University of the Free State, RSA, <sup>6</sup>Florisbad Quaternary Research Department, National Museum, Bloemfontein, RSA, <sup>7</sup>Karoo Palaeontology Department, National Museum, Bloemfontein, RSA

Carbon isotope analyses of tooth enamel have been widely employed by paleoanthropologists to understand past habitats. However, most such studies use large- to medium-bodied mammals, which maintain similar diets across heterogeneous environments, diminishing their value as paleoenvironmental proxies in mosaic systems. Even mixed-feeding taxa do not reliably record environmental characteristics (i.e. relative abundance of C<sub>3</sub> and C<sub>4</sub> vegetation) in their carbon isotope compositions. However, the carbon isotope compositions of small mammal communities and/or species may provide higher resolution paleohabitat information because small mammals are common in the fossil record, diverse in dietary/habitat preference, yet have limited lifespans and home range sizes. To investigate this possibility we assessed the degree to which carbon isotope compositions of small mammal communities record spatial changes in vegetation in a southern African savanna environment. Sampling sites ranged from very open (~5% canopy cover) to wooded (~60% canopy cover). Our results suggest that small mammal communities, on the whole, are relatively poor indicators of the relative abundance of C<sub>3</sub> and C<sub>4</sub> vegetation in local environments, although focusing on specific taxonomic groups or on certain individual taxa show promise in this regard. To complement this modern study, we performed isotopic analysis of the enamel of fossil small mammals from three hominin-bearing sites in the Cradle of Humankind, South Africa. At a general level, the fossils exhibit higher  $\delta^{13}\text{C}$  values than their modern counterparts, suggesting a greater contribution of C<sub>4</sub> resources to the diets of small mammals in the past than occurs today.

## Dental remains of Late Pleistocene European foragers: external and internal characterization

MONA LE LUYER

School of Anthropology and Conservation, University of Kent, UMR 5199 PACEA, University of Bordeaux

Teeth provide a wealth of unique information about taxonomy, phylogeny, and development that are mainly stored within tooth tissues. While variability of internal tooth structure (in particular, enamel thickness) within the genus *Homo* has been considered at a macroevolutionary scale, microevolutionary tendencies in *Homo sapiens* across the Late Pleistocene are still unreported. At the external level, a reduction of crown dimensions and a morphological simplification have been recorded throughout the Upper Paleolithic. The aim of this study is to use a high-resolution microCT record to explore how the external structural reduction is expressed in internal dental tissues for humans between ca. 20000 to 10000 cal BP. The sample is composed of 210 teeth of individuals (MNI=20) dated from Middle Magdalenian, Upper Magdalenian and Azilian French sites, from which 40 deciduous and permanent teeth have been microscanned. External assessment (crown dimensions, nonmetric variations) has been combined with internal structure analysis (enamel thickness, dental tissue proportions) using 3D imaging methods, in order to characterize the dental variability from a whole crown perspective. While a decrease in crown size has been confirmed, results from the internal tooth analyses show different patterns for enamel and dentine components between deciduous and permanent teeth, upper and lower ones, as well as between anterior and posterior dentition. In particular, the deciduous teeth that are more conservative shows that major differences occurred between specimens dated from the Upper Magdalenian and the Azilian periods. Thus, the evolutionary tendencies are more complex when we considered the internal tooth structure.

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## Comparison of Neandertal Mandibular First Molar Occlusal Outlines using Elliptical Fourier Function Analysis

FRANK L'ENGLE WILLIAMS<sup>1</sup> and JULIET K. BROPHY<sup>2</sup>

<sup>1</sup>Anthropology, Georgia State University, <sup>2</sup>Geography and Anthropology, Louisiana State University

Neandertal mandibular first molars are well represented in the fossil record permitting an examination of potential shape differences that may correspond to variation in ecogeography or chronology. To address whether ecogeography or chronology can account for occlusal outline shape differences of Neandertal mandibular first molars, a total of nine individuals were examined from different regions, including Northern Europe, central and SW France and the Mediterranean from older fossils such as Montmaurin, Sclayn and Malarnaud and more recent ones including

l'Hortus 2, l'Hortus 4, l'Hortus 5, Arcy-sur-Cure, Engis 2 and La Quina 5. Occlusal outlines were obtained from photographic images using MLmetrics and then processed with Elliptical Fourier Function Analysis which yielded 24 amplitudes of the harmonics. A cluster analysis on the size standardized data revealed that the shortest distances are between l'Hortus 4 and l'Hortus 5 and between l'Hortus 2 and Sclayn both pairs of which are joined by a relatively short distance. This cluster is joined by another pair—which includes La Quina 5 and Engis 2—via a relatively short branch length. These six fossils are joined by a medium branch length to Arcy-sur-Cure. The most distinct Neandertals are Malarnaud and Montmaurin which are joined together by a relatively long branch length. These results indicate that both ecogeography and chronology explain Neandertal occlusal shape variation albeit in different ways. Mediterranean Neandertals show a close affinity to one another. However, the most distinct fossils are also some of the oldest Neandertals in the sample, such as Malarnaud and Montmaurin.

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## Effect of age on nonmetric cranial traits for sex estimation in subadults and adults

KATE M. LESCIOTTO and LILY J. DOERSHUK

Department of Anthropology, Pennsylvania State University

Walker (2008) presented a standardized set of commonly used nonmetric cranial traits including the nuchal crest, mastoid process, supraorbital margin, glabella, and mental eminence for sex estimation of unknown skeletal remains. Since its publication, only a single study has examined the impact of age on the Walker scores, finding that any effects were inconsequential for an adult sample. The aims of this study were to (1) validate those results in adults and (2) extend the study to subadults. In this study, a large sample of adults (20-80+ years; n=272) and a small sample of subadults (10-19 years; n=36) of European-American and African-American ancestry from the Hamann-Todd Osteological Collection were used to examine the accuracy and age effect of the Walker method. For adults, Walker's glabella-mastoid-mental eminence equation produced the highest accuracy rate of 87.8%, while Walker's glabella-mental eminence equation produced the highest accuracy rate of 77.1% for subadults. Subadult accuracy increased to 85.7% for ages 17-19, which accounted for the majority of the subadult sample. As expected, Jonckheere-Terpstra trend tests revealed a significant, but practically negligible, effect on the supraorbital margin, glabella, and mental eminence traits for the adult sample (all  $p < 0.05$ ,  $\tau_b < 0.27$ ), while age had a significant effect on all five traits with

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higher effect sizes for the subadult sample (all  $p < 0.01$ ,  $\tau_b > 0.351$ ). These results offer novel insights into the effect of age, particularly among subadults, on the utility of the Walker nonmetric cranial traits.

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### Why Eating Flies and other very tiny Animals was Probably Important to No-longer-living, Human-like Animals

JULIE J. LESNIK

Department of Anthropology, Wayne State University

As a paleoanthropologist studying the evolution of the human diet, I often find myself critiquing the popular "paleo diet" trend. I argue that there was no single "paleo diet" in the past, that daily variation was not only common but important, and that heavy reliance on meat is an exception, not the rule. However, the early archaeological record preserves a disproportionate amount of meat-related artifacts, leading to more publications on the topic. Without an understanding of taphonomic processes, this abundant evidence of butchering can easily be interpreted as the most common food-related activity in which our hominin ancestors participated. It is a challenge for scholars to communicate their research in a way that is simple enough for the public to understand, while still maintaining an accurate portrayal of the complexity of scientific inquiry. Here I present my work on reconstructing the insect portion of the hominin diet using only the 1,000 most commonly used words in the English language. Although this oversimplified discussion does not lend itself to nuanced theory, and the limited word choices complicate communication with an excess of descriptors, it demonstrates a level of attention that is often not given to non-academic pursuits. It can take considerable effort to distill our results into a message understandable outside our specialty, but this diligence is required if we want our research to make the broader impacts we often desire.

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### Health Conditions of Enslaved Africans, Freeman and Poor White Workers: A Biocultural Approach

ANDREA LESSA<sup>1</sup>, GUADALUPE N. CAMPOS<sup>2</sup> and REINALDO B. TAVARES<sup>1</sup>

<sup>1</sup>Antropologia, Museu Nacional - Universidade Federal do Rio de Janeiro, <sup>2</sup>LAMET, Museu de Astronomia e Ciências Afins

Skeletal remains of adults and subadults buried between 1791 and 1849 - primary and secondary burials, minimum of 32 individuals - were excavated in the back external area of São Gonçalo Garcia Church, Rio de Janeiro, Brazil. Historical data and documentary records, the location and deposition of two burials, besides the presence of African amulets and an individual with intentional tooth modification, indicate that they were enslaved Africans, 'crioulos', 'ladinos', freemen

and poor white workers. Although it is expected an expressive physical demand in these social groups, fractures were not observed in the axial or appendicular skeleton, and the vertebrae presented low frequencies of osteoarthritis (cervical 9.3%; thoracic 6%; lumbar 5%) and absence of spondylolysis and Schmorl nodes. Only two skulls (9%) show porotic hyperostosis and cribra orbitália. The high frequency of dental caries (32.9% of 282 teeth), however, indicates a bad condition of oral health, probably associated with a diet with high level of carbohydrate and lacking or insufficient oral hygiene practices. These data are relevant since they reveal information about health conditions of slaves and poor people who lived in Rio de Janeiro in a period with a big gap of bioarchaeological studies. This scenario is associated with the impossibility of systematic excavations in ecclesiastical burial spaces, as well as the poor state of preservation of the bones in the case of sites specifically destined for the burial of the enslaved population due to the practice of punching the bodies with heavy pestles and/or burn them.

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### A quantitative analysis of iodine stained CT (DiceCT) measurements in physical and digital dissection

JUSTIN LEVY<sup>1</sup>, PATRICK J. LEWIS<sup>1</sup> and ADAM HARTSTONE-ROSE<sup>2,3</sup>

<sup>1</sup>Department of Biological Sciences, Sam Houston State University, <sup>2</sup>Department of Cell Biology and Anatomy, University of South Carolina School of Medicine, <sup>3</sup>Department of Anthropology, University of South Carolina

The use of iodine staining in computed tomography (CT) has increased greatly in recent years, revolutionizing the study of in situ soft tissues in three dimensions. The advent of this approach requires more research to compare measurements from CT and traditional dissection methods. To this end, the head of a common marmoset, *Callithrix jacchus*, was stained in 2.5% Lugol's solution for 37 days, with fresh solution supplied after 20 days, and studied digitally. Prior to and following staining, the head was CT scanned, then physically dissected. Amira was used to digitally segment and isolate a variety of soft tissue structures, comprising all four major tissue types: connective, epithelial, muscle, and nervous. Over 50 measurements were recorded to evaluate the difference between the digital and traditional dissections using percent error and regression. We found that this technique is generally reliable and an improvement for exceedingly small tissues that are difficult to measure traditionally. One important observation is that staining regimes vary depending on the tissues targeted for optimal evaluation. Thus, while our specimen was optimized for myology, the glands were not stained as clearly and staining the deepest parts of the brain requires an amount

of iodine that oversaturates muscle visibility. This process could be widely beneficial when traditional destructive dissection is not possible. It allows for three dimensional views of structures that are not otherwise visible due to size and/or morphology, however, study of multiple types of tissues requires serial scanning after variable staining regimes.

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### Examining Heavy Metal Concentrations in Hair of South African Vervet monkey (*Chlorocebus pygerythrus*) to access Anthropogenic Impacts

ALYCIA E.A. LEWIS<sup>1</sup>, JAMES E. LOUDON<sup>1</sup>, JACK E. PENDER<sup>2</sup>, JOSHUA C. ANDREWS<sup>2</sup>, MICHAELA E. HOWELLS<sup>3</sup>, J. PAUL. GROBLER<sup>4</sup> and TRUDY R. TURNER<sup>4,5</sup>

<sup>1</sup>Department of Anthropology, East Carolina University, <sup>2</sup>Department of Chemistry, East Carolina University, <sup>3</sup>Department of Anthropology, University of North Carolina - Wilmington, <sup>4</sup>Department of Genetics, University of the Free State, <sup>5</sup>Department of Anthropology, University of Wisconsin - Milwaukee

High concentrations of heavy metals are known to have deleterious effects on the nervous, endocrine, hepatic, and immune systems of mammals. Environmental toxicology has traditionally been used to understand impacts of pollutants on human health and aquatic and marine ecosystems but has rarely been adopted by primatologists to examine the effects of toxins on nonhuman primates (NHPs). We analyzed 64 vervet monkey (*Chlorocebus pygerythrus*) hair samples for concentrations of Arsenic (As), Cadmium (Cd), Lead (Pb), and Mercury (Hg) using an inductively coupled plasma mass spectrometer. Hair samples were collected from anesthetized monkeys at 10 South African field sites with varying degrees of anthropogenic impact. All hair samples contained Pb. Some samples had As, Cd, and Hg but often at levels too low to quantify. Animals acquire heavy metals naturally via environmental particulates, or through the consumption of food and water and sometimes in unnaturally high quantities as a result of human activity. In South Africa, mining is fairly widespread with the harmful byproduct of toxic levels of heavy metal pollution. Three of the vervet sites we examined were nearby mines or water sources adjacent to mines and were periodically used by local people. Given our shared physiologies, NHPs can act as proxies for those humans occupying polluted ecosystems, and the data collected from examining NHP hair for pollutants may also be viewed as less controversial by public and private institutions. We assert that toxicology studies can improve our understanding of NHP health and behavior especially for populations in degraded habitats.

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### Invisible transitions: the search for new osteological signatures of menarche

MARY E. LEWIS<sup>1</sup> and FADIL ELAMIN<sup>2</sup>

<sup>1</sup>Archaeology, University of Reading, <sup>2</sup>n/a, Khartoum Centre for Research and Medical Training

Current osteological methods to assess whether a female has achieved her first menarche (e.g. fusion of the hand and wrist, appearance of the iliac crest epiphyses) suffers from seemingly insurmountable problems; a) Iliac crests are rarely preserved, and b) collections of known age female adolescent skeletons, even with medical records, do not report age of menarche. This research aimed to establish whether there was a link between the age of menarche, maturation of the cervical vertebrae (CVM), and development of the hand and wrist bones in a known menarche status group. Data was collected from a series of modern clinical radiographs of 116 girls from northern Sudan aged between 9.5 and 20.6 years.

The result indicated that: individual carpal bones may aid in separating girls pre- and post-menarche; all of the metacarpals had finished developing one-year post-menarche, Stage 6 CVM only occurred in the post-menarche groups and stages 1 and 2 CVM only occurred in the pre-menarcheal groups. While this research suggests there is a potential to refine our osteological methods, further work comparing these result to the skeletal development of boys of the same age is required.

### Evolutionary patterns of intersexual power: The rise of male dominance in primates

REBECCA J. LEWIS<sup>1,2</sup>, E. CHRISTOPHER KIRK<sup>1</sup> and ASHLEY D. ASHLEY GOSSELIN-ILDARI<sup>3</sup>

<sup>1</sup>Anthropology, University of Texas-Austin,

<sup>2</sup>Ankoatsifaka Research Station, Kirindy Mitea National Park, <sup>3</sup>Evolutionary Anthropology, Duke University

Sex-based power inequality is pervasive in primates. We hypothesized that both dominance and leverage influence sex-based power. If sexual dimorphism causes intersexual dominance, we predicted that highly dimorphic species are constrained to be male dominant, and low dimorphism species are free to demonstrate any pattern of power. If market effects influence intersexual leverage, we predicted that females have more power when social group sex ratios are more female-biased and estrus is asynchronous. We analyzed intersexual dominance status, body mass and canine ratio, expected estrous overlap, reproductive seasonality, and sex ratio data for 79 primate species using phylogenetic logistic regression and ancestral state reconstructions (ASRs). While male dominance is most common in primates, every major extant clade includes at least one species that is not male dominant. Male dominance was significantly associated with greater dimorphism in body mass and

canine length and with female-biased sex-ratios. Very low expected estrus overlap was significantly associated with female dominance and co-dominance. Based on multiple ASR analyses, male dominance was not necessarily the ancestral condition for primates, strepsirrhines, or haplorhines. The anthropoid last common ancestor (LCA) was probably male dominant but likely did not exhibit high sexual dimorphism. High dimorphism probably characterized the catarrhine LCA, which constrained dominance relationships within this clade and helps explain why living catarrhines are primarily male dominant. Male dominance evolved multiple times in primates and is probably common because multiple traits are linked to male dominance but fewer traits are associated with female dominance or co-dominance.

### Functional analysis of lower ilium shape and robusticity in Plio-Pleistocene hominins

KRISTI L. LEWTON

Keck School of Medicine, Department of Cell and Neurobiology, University of Southern California

Iliac strength is thought to be increased during upright postures by shortening the load arm between the sacroiliac and hip joints to decrease bending, and by increasing the overall robusticity of the lower ilium to resist the larger forces that are transmitted through it. Although fossil hominin lower ilia are frequently described as short and robust, their cross-sectional area (LICSA) and robusticity have never been quantified. This study used 3D surface scanning methods to capture pelvic shape of *Australopithecus africanus*, *A. afarensis*, *A. sediba*, *Homo erectus*, and *Paranthropus robustus*. In addition to scaled LICSA and lower iliac height, an index of robusticity was determined as the ratio of lower ilium cross-sectional area to its height. Adaptive hypotheses of lower iliac form were tested in fossil hominins and a comparative sample of extant hominoids using analyses of variance and ordinary least squares regression. Results revealed statistically significant differences across taxa in each measure. Chimpanzees and gorillas have similar robusticity indices, indicative of relatively slender lower ilia. Modern humans and fossil hominins overlap, and have significantly more robust lower ilia than extant apes. Finally, LICSA shape differs between apes and hominins, suggesting possible strengthening against mediolateral bending within hominins. These results support the assertion that a short, robust lower ilium is an adaptation to the increased loads that occur during bipedal (compared to quadrupedal) behaviors. Additional research is necessary to better understand the timing of evolution of lower ilium robusticity in relation to the advent of bipedality in the hominin clade.

### Human Settlement History of Papua New Guinea Highland Populations

MIAN LI<sup>1</sup>, KATE DEROSA<sup>2</sup>, HAYLEY MANN<sup>2</sup>, AMANDA ROOME<sup>2</sup>, STEPHEN SCHUTTA<sup>2</sup>, DANIEL CASTELLANOS<sup>2</sup>, SAMANTHA BENDER<sup>2</sup>, JESSICA ECHARD<sup>2</sup>, KALEN CASEY<sup>2</sup>, MICHEL SHAMOON-POUR<sup>2</sup>, KYLE GOWEN<sup>2</sup>, RITA SPATHIS<sup>2</sup>, RALPH GARRUTO<sup>1,2</sup> and KOJI LUM<sup>1,2</sup>

<sup>1</sup>Biological Science, Binghamton University,

<sup>2</sup>Anthropology, Binghamton University

New Guinea was first settled at least 40,000 years ago and is currently home to ~11,000,000 people speaking nearly 1/6th of the world's languages. The Eastern Highlands of New Guinea was unknown to the outside world until the 1930s. Highlanders lived extremely isolated lives, rarely venturing from their valley of birth because of rugged mountainous terrain and constant, low intensity warfare with their neighbors.

In order to gain insight into the effects of Pleistocene settlement and local isolation on the maintenance of genetic and linguistic diversity, we characterized the mtDNA HVSI diversity of 870 early contact Eastern and Southern Highlanders who donated their serum in the 1950s-1960s. These people were from 20 villages representing 14 languages. The majority of these villages are within a contiguous 75km diameter region of the Eastern Highlands. In addition, 200 whole mtDNA genomes, which distributed evenly across villages, were sequenced using the Illumina platform.

A total of 116 unique haplotypes were detected based on the mtDNA HVSI region and all were assigned to 4 haplogroups (P=54.9%, Q=43.8%, N13=1%, R14=0.3%) based on additional SNP data from the whole mtDNA data set. Preliminary analysis revealed a significant correlation ( $p < 0.001$ ) between genetic and linguistic distances, suggesting linguistic barriers have restricted gene flow. In addition, 25 heteroplasmic positions detected with Sanger sequencing were all confirmed with high-throughput sequencing. Furthermore, the 200 New Guinea Highland whole mtDNA sequences we generated allowed us to refine the phylogeny of haplogroups P and Q and better understand the Pleistocene settlement of Sunda and Sahul.

National Geographic--The Genographic Project

### Testing hypotheses about hominin locomotor evolution using models not analogies

DANIEL E. LIEBERMAN<sup>1</sup>, MEIR M. BARAK<sup>2</sup>, CAMPBELL P. ROLIAN<sup>3</sup>, DAVID A. RAICHLIN<sup>4</sup> and HERMAN PONTZER<sup>5</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University,

<sup>2</sup>Department of Biology, Winthrop University, <sup>3</sup>Faculty of Veterinary Medicine, University of Calgary, <sup>4</sup>School of Anthropology, University of Arizona, <sup>5</sup>Department of Anthropology, Hunter College

## ABSTRACTS

Despite persistent critiques that many hypothesized adaptations are spandrels, a majority of evolutionary biologists accept that organisms are replete with adaptations: derived, novel features selected to improve reproductive success. Even so, testing hypotheses about adaptations is tricky for fossil taxa because one can only infer if a hypothesized adaptation improved performance for some function that would have benefited survival and reproduction. What, however, should be the standard to test improved performance? Many studies of functional morphology rely on correlations to test if morphological features associated with a given function in extant species are similar to those of fossil taxa. For example, morphologies associated with tree-climbing species are assumed to be adaptations for tree-climbing. However, these correlations are analogies, don't measure performance, and it is problematic to assume that organisms in the past behaved only like extant species. The better alternative is to test experimentally biomechanical and physiological models about the relationship between form and function in living organisms, and then test for the presence or absence of these features in fossils and comparative extant species. To illustrate this approach, I use three examples in which my colleagues and I evaluated hypotheses about early hominin walking and running gaits by first testing biomechanical models in humans and other extant species: phalanx length, trabecular orientation, and gluteus maximus size. These studies highlight the benefit of testing biomechanical models over just relying on analogies, and indicate that australopiths walked with relatively extended lower extremities but would have faced challenges during long distance running.

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### **Coping with low-quality habitat: white-handed gibbons (*Hylobates lar*) alter diet and activity patterns where fig trees are scarce**

LYDIA E. O. LIGHT

Anthropology, University of North Carolina at Charlotte

Activity patterns can reveal important information about how primates cope with challenging ecological conditions. This study compares activity budgets of white-handed gibbons (*Hylobates lar*) living in two distinct habitats in Western Thailand. I spent thirteen months studying four social groups in Huai Kha Khaeng Wildlife Sanctuary where gibbons are found living in both evergreen and mosaic habitats. The two habitats differed most notably in fig tree density with large fig trees (>40 cm DBH) three times more abundant in evergreen habitat than mosaic

habitat. Compared to mosaic gibbons, evergreen gibbons spent less percentage of time feeding (22.5% vs. 28.9%;  $U = 613$ ,  $N_1 = 43$ ,  $N_2 = 44$ ,  $p = 0.005$ ) and more percentage of time vocalizing (12.1% vs. 4.2%;  $U = 496.5$ ,  $N_1 = 43$ ,  $N_2 = 44$ ,  $p < 0.001$ ). In the evergreen habitat, ripe fruit availability was positively correlated with percentage of time feeding [ $r = 0.400$ ,  $p = 0.008$ ] and engaged in social activities [ $r = 0.309$ ,  $p = 0.044$ ]. In the mosaic habitat, ripe fruit availability was not correlated with activity categories but flower availability was negatively correlated with percentage of time feeding [ $r = -0.381$ ,  $p = 0.011$ ] and positively correlated with percentage of time engaged in social activities [ $r = 0.306$ ,  $p = 0.044$ ]. I conclude that 1) mosaic gibbons cope with a shortage of fig trees in mosaic habitat by increasing the proportion of time spent feeding and that 2) flowers may be an important resource when available.

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### **The Effect of Pathology on Bone Microstructure: Implications for Histological Age Estimation**

CAROLINE E. LILL<sup>1</sup>, JULIETA G. GARCIA-DONAS<sup>2</sup>, ROBERT R. PAINE<sup>3</sup>, BLEDDAR XHEMALI<sup>4</sup> and ELENA F. KRANIOTI<sup>5</sup>

<sup>1</sup>Classics and Archaeology, Archaeology Department, University of Edinburgh, <sup>2</sup>Classics and Archaeology, Archaeology Department, University of Edinburgh, <sup>3</sup>Sociology & Anthropology, Texas Tech University, <sup>4</sup>Department of Forensic Medicine, Forensic Institute of Albania, <sup>5</sup>School of History, Classics and Archaeology, Archaeology Department, University of Edinburgh

This study investigates disruptions in bone metabolism using bone histomorphometry in individuals with chronic metabolic diseases (CMD) and their effect on histological age estimation methods. Thirty six samples (12 pathological and 23 controls) from the 4-6th left ribs are taken from autopsy cases from two forensic departments in Greece and Albania. Age range was 19 to 101 years old. Thin sections of each sample were prepared and several histomorphometric variables such as intact and fragmented osteons, osteon population density (OPD), relative cortical area (cortical area/cross-sectional area of the rib) were quantified. Pearson's correlation coefficient was calculated for each variable and age for both CMD and healthy controls. Bone micromorphology in CMDs shows both quantitative and qualitative differences to similarly aged counterparts. The cortical bone becomes much thinner, Haversian canals often appear larger than average, osteon shape and size vary from what is normally seen in healthy individuals, and OPD is likewise affected. Unsurprisingly there is a strong negative correlation between intact osteons

and cortical area and age in CMDs compared to healthy individuals. Pearson's correlation coefficient between OPD and age was found to be strong for the healthy group ( $r=0.674$ ,  $p<0.08$ ) but very low for CMDs ( $r=0.072$ ,  $P>0.05$ ). These results indicate that samples from CMDs would have a larger error in age estimation methods using bony microstructures, such as Stout and Paine's formula for histological age prediction. A larger sample is needed to provide corrections for pathology in the existing formulae.

### **High Heritability and Ancestry Dominance are behind the Genetics of Short Stature in South African KhoeSan Populations**

MENG LIN<sup>1</sup>, JULIE M. GRANKA<sup>2</sup>, ALICIA R. MARTIN<sup>3</sup>, JUSTIN MYRICK<sup>4</sup>, ELIZABETH G. ATKINSON<sup>5</sup>, CEDRIC J. WERELY<sup>6</sup>, DEEPTI GURDASANI<sup>6,7</sup>, CRISTINA POMILLA<sup>6,7</sup>, TOMMY CARSTENSEN<sup>6,7</sup>, BROOKE SCELZA<sup>4</sup>, MARLO MOLLER<sup>5</sup>, MANJ SANDHU<sup>6,7</sup>, CARLOS D. BUSTAMANTE<sup>3</sup>, EILEEN G. HOAL<sup>5</sup>, MARCUS W. FELDMAN<sup>2</sup>, CHRISTOPHER R. GIGNOUX<sup>3</sup> and BRENNAN M. HENNI<sup>1,8</sup>

<sup>1</sup>Graduate Program in Genetics, Stony Brook University, <sup>2</sup>Department of Biology, Stanford University, <sup>3</sup>Department of Genetics, Stanford University, <sup>4</sup>Department of Anthropology, University of California Los Angeles, <sup>5</sup>Division of Molecular Biology and Human Genetics, Stellenbosch University, <sup>6</sup>Genome Campus, Wellcome Trust Sanger Institute, <sup>7</sup>Department of Public Health and Primary Care, University of Cambridge, <sup>8</sup>Department of Ecology and Evolution, Stony Brook University

Adult height is one of the classic anthropometric traits studied in different human populations, with its genetic architecture extensively explored in Europeans. It is considered greatly polygenic and additive, with a high narrow sense of heritability (~80%) from early twin studies. To gain a better understanding of how genetic components affect stature variance in indigenous cohorts, we assayed statures in two KhoeSan communities, #Khomani San and Nama ( $n=400$ ) in the rural Kalahari and Richtersveld Deserts of South Africa. These populations have continued possessing similar short statures (~155cm) compared to documented in 1940s (Trevor, 1947). Both our pedigree-based and genotyping inferred identity-by-descent (IBD) heritability estimates of height in the KhoeSan were excessively high ( $h^2=0.95$  and  $0.89$ , respectively). Simultaneously a bottom-up estimate using pairwise relationships from SNP array and exome data closely matched the pedigree results. Despite a greater environmental and household homogeneity in these populations, we were able to observe small household effect on height through higher IBD-based estimate in first-degree relatedness ( $h^2=0.94$ ). Considering recent admixture with Bantu-speakers and Europeans in the KhoeSan, we uncovered signals from certain ancestries contributing dominantly to stature variation through admixture mapping. The difference on

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ancestry heterozygosity between the two populations genetically agrees to the different documented timing of admixture with Bantu-speakers in the two communities. Taken together, these results show that the genetic architecture of height in KhoeSan endogamous cohorts are likely to differ from previously known in European populations.

### Complex Adaptive Forces Shape Skin Barrier Evolution in Humans

YEN-LUNG LIN<sup>1</sup>, MUTHUKRISHNAN EAASWARKHANTH<sup>1</sup>, PETAR PAJIC<sup>1</sup>, DUO XU<sup>1</sup>, MARGARITA RZHETSKEYA<sup>2</sup>, M GEOFFREY HAYES<sup>2</sup>, RAN BLEKHMANN<sup>3</sup>, NINA JABLONSKI<sup>4</sup> and OMER GOKCUMEN<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, University at Buffalo, <sup>2</sup>Division of Endocrinology, Metabolism and Molecular Medicine, Department of Medicine, Northwestern University Feinberg School of Medicine, <sup>3</sup>Department of Genetics, Cell Biology and Development, University of Minnesota, <sup>4</sup>Department of Anthropology, Pennsylvania State University

Skin harbors some of the most significant adaptive variations in humans as our species colonized different ecologies. However, with the exception of pigmentation, the human skin evolution has yet to be investigated in an anthropological genetics framework. Therefore, we investigated the evolutionary trends that shape the genetic variation in the epidermal differentiation complex on chromosome 1, which harbors more than 50 genes with known roles in skin barrier function. Here, we focus on two loci in this complex. First, we found that a common, 32kb deletion of *LCE3B* and *LCE3C* genes has remained in the human population since before Human-Denisovan divergence likely due to balancing selection. Second, upstream of the *LCE3* locus, we detected a selective sweep, which increased the allele frequency of a distinct haplotype of filaggrin (*FLG*) gene in Asian populations. We further found that this haplotype is associated with expression levels of multiple nearby genes and microbiome diversity on the skin. Moreover, *LCE3BC* deletion and the selected *FLG* haplotype are associated with increased susceptibility to pathologically similar skin diseases, atopic dermatitis and psoriasis, respectively. However, it is not clear why these two common alleles remain in the population for hundreds of thousands of years and not eliminated by negative selection. Interestingly, patients with psoriasis have lower susceptibility to atopic dermatitis, and vice versa. Collectively, we put forward a model of skin evolution where particular disruptions of skin barrier function lead to different microbial compositions of the skin, creating a balance between autoimmunity and natural vaccination.

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### Patterns of Genetic Coding Variation in a Native American Population Before and After European Colonization

JOHN LINDO<sup>1</sup>, BARBARA PETZELT<sup>2</sup>, JOYCELLYN MITCHELL<sup>2</sup>, MICHAEL DEGIORGIO<sup>3</sup> and RIPAN S. MALHI<sup>4</sup>

<sup>1</sup>Department of Human Genetics, University of Chicago, <sup>2</sup>Metlakatla, Metlakatla Treaty Office, <sup>3</sup>Departments of Biology and Statistics, Pennsylvania State University, <sup>4</sup>Department of Anthropology, University of Illinois, Champaign-Urbana

The effects of European colonization on the genomes of Native Americans may have produced excesses of potentially deleterious features, mainly due to the severe reductions in population size and the associated loss of genetic diversity. This assumption, however, does not take into account actual genomic patterns that existed before colonization; nor does it adequately capture the effects of non-native admixture with indigenous populations. In this study, we analyze the whole-exome sequences of modern and ancient individuals from a Northwest Coast Native American group, with a demographic history characteristic of other indigenous populations from the Americas. We show that in approximately ten generations from initial European contact, the modern individuals show reduced levels of private and rare variants, reduced levels of potentially deleterious alleles, and increased levels of heterozygosity, when compared to their ancestors. This pattern, which is unexpected after such a dramatic population decline, can be explained by certain mitigating factors, including the increased genetic diversity stemming from admixture with non-native groups. This study examines the genomic consequences of colonialism on an indigenous population and describes the role of gene flow in rapidly mitigating deleterious features.

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### Bioarchaeological Assessment of Childhood Morbidity during the Coles Creek Period in the southern Lower Mississippi Valley

GINESSE A. LISTI

Department of Geography and Anthropology, LSU

This study uses dental pathologies and cranial porous lesions (CPLs) to assess childhood morbidity during the transitional Coles Creek period in the southern Lower Mississippi Valley. Forty-two individuals from multiple sites ranging in date from 800 BC to AD 1200 were examined for dental caries, calculus, abscesses, and linear enamel hypoplasias (LEHs) and for CPLs. Based on dental development, the sample was separated into "infants" less than two years (n=21), "juveniles" between two and ten years (n= 15), and "subadults" between 11 and 18 years (n=6). For each age group, data were separated into

"Coles Creek" and "Pre-Coles Creek" categories and temporal changes in the frequencies of pathological conditions were assessed.

Results show that infants exhibit few dental pathologies: only one individual has caries. Among juveniles, neither abscesses nor calculus is observed. Caries decrease significantly through time, while LEHs show a non-significant decrease. Among subadults, no caries are observed, calculus decreases through time (non-significant), and LEHs could not be assessed.

For CPLs, infants show a decrease through time for orbits and occipitals, but an increase for parietals. Juveniles decrease for orbits, but increase for occipitals and parietals. None of these temporal changes is significant. Finally, subadult CPLs increase through time for all elements, but the change was not assessed statistically due to small sample sizes.

In conclusion, the Coles Creek period is characterized by changes in diet, population size, and cultural complexity. In addition to these changes, childhood morbidity also appears to increase during this transitional time.

### A Study of Human Tooth Eruption and Root Growth

HELEN M. LIVERSIDGE

Dental, Queen Mary University of London

Human teeth erupt during root growth but few studies report the relationship between root fractions and eruption levels. The aim of this study was to assess root stages of deciduous and early erupting permanent teeth (central incisors and first molars) at alveolar and partial eruption levels and relate this to root fraction and tooth length. The sample consisted of 613 modern human skeletal remains with developing teeth as well as dental radiographs of 1861 individuals aged 2-11 years. Tooth stage (Moorrees crown and root stages) and eruption levels of all developing teeth were assessed where possible. Tooth length of isolated teeth from the skeletal material was measured. The distribution of root stage at eruption levels was calculated. Results showed that 79% of 177 deciduous teeth and 72% of 138 permanent first molars at root a quarter (R1/4) had reached alveolar eruption or beyond. This pattern at R1/4 was different in the permanent incisors. Most upper incisors at R1/4 were unerupted in contrast to almost half of mandibular incisors at alveolar eruption or beyond. Most teeth at alveolar eruption or partial eruption were observed at R1/4 or at root one half (R1/2), however a proportion of teeth at R1/4 were partially erupted. Half of 139 deciduous teeth and 20 to 33% of the permanent teeth at R1/2 had reached full eruption. These findings suggest that the active phase of eruption occurs during the first half of root growth and can be a rapid process although considerable variation occurs.

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### Subregion-scale heterogeneity in bovid abundance in the Koobi Fora Formation (Pleistocene, Northern Kenya)

CATHERINE LLERA<sup>1,2</sup>, LORENA BENITEZ<sup>1,3</sup>, MARYSE BIERNAT<sup>1,4</sup>, DAVID R. BRAUN<sup>1,5,6</sup>, ASHLEY S. HAMMOND<sup>1,5</sup>, DAVID B. PATTERSON<sup>1,5,7</sup> and W. ANDREW BARR<sup>1,5</sup>

<sup>1</sup>Koobi Fora Field School, The George Washington University and National Museums of Kenya,

<sup>2</sup>Anthropology, University of Florida, <sup>3</sup>Organismic and Evolutionary Biology, Harvard University,

<sup>4</sup>Anthropology, Smithsonian Institution, <sup>5</sup>Center for the Advanced Study of Human Paleobiology,

Department of Anthropology, The George Washington University, <sup>6</sup>Department of Human Evolution, Max Planck Institute for Evolutionary

Anthropology, <sup>7</sup>Department of Biology, University of North Georgia

Reconstructing landscape heterogeneity across space is critical for understanding how hominins interacted with their environments during the Pleistocene. We used bovid tribal abundances to examine spatial variation in paleoenvironments across subregions of the Koobi Fora Formation during Upper Burgi (~2.0 – 1.87 Ma), KBS (1.87 – 1.52) and Okote (1.52 – 1.38 Ma) times. We tested the hypothesis that subregions differ in tribal abundance due to paleoenvironmental variation mediated by the distance to the axis of the sedimentary basin. We hypothesized that the Karari Ridge subregion (most distant from the basin axis) would differ from the Koobi Fora Ridge and Ileret subregions (closer to axis) in having fewer hydrophilic bovids such as reduncins.

Counts for reduncin, alcelaphin, and tragelaphin bovids (1405 total) were obtained by combining the Turkana Basin Paleontology Database with new fossil collections. We calculated faunal abundance of each bovid tribe per member and collection area and imported the output to QGIS software to visualize the distribution of each tribe in each paleontological collection area. The Karari Ridge subregion tribal abundances differed ( $p < 0.001$ ) from the Koobi Fora Ridge and Ileret subregions during KBS Member times. The high abundance of alcelaphins and low abundance of reduncins at Karari is consistent with habitat differences related to the distance from the basin axis. This study attests the importance of faunal abundance data for tracing subregional variation in paleoenvironments. Future work will add to our understanding of how landscape variability, driven by paleogeographic and paleoclimatic forces, has influenced hominin behavior and evolution.

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### 3D geometric morphometrics of lumbar vertebral curvatures in *H. sapiens*

STEPHANIE LOIS ZLONISKI<sup>1</sup>, DANIEL GARCÍA MARTÍNEZ<sup>1</sup>, ESTHER BLANCO-PÉREZ<sup>2</sup>, JUAN A. SANCHIS GIMENO<sup>3</sup>, ALON BARASH<sup>4</sup>, SANDRA MARTELLI<sup>5</sup>, SHAHED NALLA<sup>6,7</sup> and MARKUS BASTIR<sup>1</sup>

<sup>1</sup>Paleoanthropology Group, Museo Nacional de Ciencias Naturales, CSIC, <sup>2</sup>Department of Radiology, University Hospital de La Ribera, <sup>3</sup>Department of Anatomy and Human Embryology, Faculty of Medicine, University of Valencia, <sup>4</sup>Faculty of Medicine Galilee, Bar Ilan University, <sup>5</sup>Department Of Cell And Developmental Biology, University College London, <sup>6</sup>Department of Human Anatomy and Physiology, Faculty of Health Sciences, University of Johannesburg, <sup>7</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand

Recent research has shown that lumbar lordosis is an important factor in bipedal locomotion and has been also related to adaptations to pregnancy. Several studies, using different methods, indicate males are less lordotic than females. Previous research also found differences between African and European populations suggesting geographic variation. Lumbar lordosis is frequently assessed on the wedging of the vertebral bodies.

Here we address the hypotheses on sexual dimorphism in lumbar lordosis using 3D geometric morphometrics and explore its interactions with geographic variation. We measured 390 (semi)landmarks in 3D reconstructions of computed tomography scans of lumbar vertebral bodies and intervertebral discs on 7 males and 9 females from a European population (Spain, Israel) and 7 males and 8 females from a South African population with African ancestry.

Mean shape comparisons reveal that females are significantly more lordotic than males with relatively higher and narrower lumbar segments (vertebral body and the contiguous intervertebral disc below). We also find that the populations from Europe are less lordotic than the population of South Africa, similarly, with more lordotic ones being narrower.

However, while the greater lordosis in Europeans was caused by posterior wedging of the L4 and L5 vertebral bodies, the greater female lordosis in sexual dimorphism was linked to greater dorsal wedging of the intervertebral discs of L4 and L5.

This suggests that estimates of lordosis on bones can be problematic as the intervertebral discs can contribute substantially to the curvature of the lumbar vertebral column, which is an anatomical composite system.

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### The Household Ecology of Enteric Pathogen Transmission, Diarrheal exposure Risk and Impaired Childhood Growth in Rural Bangladesh and Kenya

KURT Z. LONG<sup>1</sup>, ABU SG. FARUQUE<sup>2</sup>, TAHMEED AHMED<sup>2</sup>, INONG GUNANTI<sup>1</sup>, SALVADOR ZAMORA<sup>3</sup>, JAMES P. NATARO<sup>4</sup>, DILRUBA NASRIN<sup>5</sup>, MYRON LEVINE<sup>5</sup> and KAREN KOTLOFF<sup>5</sup>

<sup>1</sup>Epidemiology and Public Health, Swiss Tropical and Public Health Institute, <sup>2</sup>Centre for Nutrition and Food Security, International Centre for Diarrhoeal Disease Research, Bangladesh, <sup>3</sup>Faculty of Sciences, National Autonomous University of Mexico, <sup>4</sup>Department of Pediatrics, School of Medicine, University of Virginia, Charlottesville, <sup>5</sup>Center for Vaccine Development, University of Maryland School of Medicine

The burden of childhood diarrhea and malnutrition remains high in developing countries due to inadequate household sanitation, lack of access to improved water and poor hygiene practices (WASH). We used structural equation models (SEM) to evaluate the effects of household factors on enteric pathogen infections (EPI) and childhood growth in rural Bangladeshi and Kenya. Stool specimens collected from children with moderate-to-severe diarrhea and matched controls were screened for bacterial, viral and protozoa EPI and their height was measured at baseline and 60 days. SEM was used to determine the direct and indirect causal pathways linking sanitation facilities, water sources, cooking fuel, hygiene behaviors and EPI with changes in height. In Bangladesh improved latrine use and increased caretaker education was associated with increased growth both directly and through the reduced prevalence of *Giardia lamblia* and *Cryptosporidium* infections. Presence of cows in the compound and the use of cow dung as fuel were linked to higher *Cryptosporidium* prevalence and reduced growth when caretakers reported no hand washing. In Kenya, river water use when water was stored in the household was directly associated with reduced growth but also had an effect through increased entero-adherent *E. coli* (EAEC) and *G. lamblia* infections. Increased caretaker education had an indirect beneficial effect on growth through increased treatment of stored water and reduced EAEC infections. Causal pathways linking WASH, infection and childhood growth in Bangladesh and Kenya were qualitatively distinct reflecting differences in household ecology and behaviors between these communities that constrain and determine these pathways.

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### Cardiovascular fitness as a signal of reproductive potential

DANIEL LONGMAN<sup>1</sup>, JONATHAN CK. WELLS<sup>2</sup>,  
MICHELE K. SURBEY<sup>3</sup> and JAY T. STOCK<sup>1</sup>

<sup>1</sup>Archaeology and Anthropology, University of Cambridge, <sup>2</sup>Childhood Nutritional Research Centre, UCL Institute of Child Health, <sup>3</sup>Department of Psychology, James Cook University

Signalling theory is an area of evolutionary biology concerned with communication both within and between individual organisms. Internal signals, which coordinate the allocation of energy within the organism, are fundamentally connected with external signals, which convey information to others. External signals thereby convey information of internalised traits which would otherwise be obscured.

Sports necessitating cardiovascular fitness were used to address the link between internal and external signalling. Here we report on the results of two studies designed to test aspects of the relationship between signalling and performance. In a test of head-to-head rowing performance, endocrine and psychological factors believed to contribute to male reproductive success were found to increase following a manipulated "win", and decrease following a manipulated "loss". The results suggest that both the endocrine and psychological systems work in tandem to regulate male reproductive investment.

Further work investigated the communication of internalised traits relative to external signals of fitness. A significant negative correlation between digit ratio (a marker of testosterone exposure) and half-marathon performance was observed in men and women, with a stronger relationship in men than women. This implies that androgenisation may have experience stronger selective pressure from physical endurance among males. Due to the widely accepted link between androgenisation and reproductive success, this association between endurance running and testosterone suggests that running prowess may be a reliable signal of male reproductive potential.

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### Functional associations between Osteoarthritis and Vertebral Osteophytosis in Prehistoric Atacama Oases, Chile

ROCIO LOPEZ BARRALES<sup>1</sup>, VIVIVANA LLAGOSTERA<sup>2</sup>, WALTER NEVES<sup>3</sup> and MARK HUBBE<sup>1,4</sup>

<sup>1</sup>Anthropology, The Ohio State University, OH, USA, <sup>2</sup>Anthropología, Universidad de Tarapacá, Arica, Chile, <sup>3</sup>Departamento de Genética e Biología Evolutiva, Universidade de São Paulo, Brasil, <sup>4</sup>Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica del Norte, San Pedro de Atacama, Chile

The prevalence of osteoarthritis (OA) on the appendicular skeleton and vertebral osteophytosis (VO) are commonly used to reconstruct activity patterns among prehistoric populations. This type of analysis usually focusing on joints, by grouping articulation facets into larger units that are then used as the basis for all analyses. However, the association between facets affected by degenerative joint disease within and between joints is rarely explored. Here analyze these associations in a series of 153 prehistoric adult individuals from the Atacama Oases, Chile, with the goal of describing the possible functional associations observed between articular facets in the past. Spearman correlations between facets were calculated based on the ranked degree of OA and VO, and significant correlations with  $r > 0.5$  were considered as strongly associated. The results show strong associations are more frequent between articular facets belonging to the same joint or same functional unit, with elbows, knees and wrists showing the stronger correlations. Among the vertebrae, the pattern of correlations identifies four anatomical units: Atlas and Axis; C3-C7; thoracic; and lumbar. Between joints, bilateral associations were observed throughout the body, with the notable exception of wrists and ankles that show no bilateral correlation. Finally, strong associations are more common between articulation facets belonging to the same bones, than between facets from different bones, even within joints. Our results suggest that the joints and articular facets were engaged in complex ways in the individuals from the Atacama oases, and that activity patterns cannot be easily reconstructed from the analysis of joints independently.

*Becas Chile-Conicyt*

### Spectroscopic Approach to Human Bone/ Collagen in Pre-industrial Populations: Preservation vs Chronic Diseases

OLALLA LÓPEZ-COSTAS<sup>1,2,3</sup>, MARCELA RIAL TUBÍO<sup>4</sup>, JOERI KAAL<sup>5</sup> and ANTONIO MARTÍNEZ CORTIZAS<sup>4</sup>

<sup>1</sup>Group Earth System Science - Dpt Geography, Universidade de Santiago de Compostela, Spain, <sup>2</sup>Archaeological Research Laboratory, Stockholm University, Sweden, <sup>3</sup>Laboratory of Physical Anthropology, Universidad de Granada, Spain, <sup>4</sup>Group Earth System Science - Dpt Edafología e Química Agrícola, Universidade de Santiago de Compostela, Spain, <sup>5</sup>Pyrolyscience, private company, Pyrolyscience, Santiago de Compostela, Spain

Bone remains from pre-industrial populations are suitable and accessible models to understand skeletal biology, including the presence of advanced chronic infections. In this case, bone and its proteins (collagen) could show modifications due to both pre-mortem (e.g. disease) and post-mortem processes. Our work pretend to characterize the skeletal molecular structure in

healthy and unhealthy individuals using non-destructive spectroscopic techniques combined with multivariate statistics.

Non-pathological bone and extracted collagen (n=55, ribs) were characterized using FTIR-ATR spectroscopy. We also analyzed skeletal pieces (n=10) showing pathological signs compatible with chronic infections (tuberculosis, brucellosis and treponematosis). Samples were recovered in 9 necropoleis from Spain, representing a wide chronological period (~3,500 years). The second derivative were used to identify the most relevant absorption bands. Principal components analysis (PCA) and multiple regression models were developed to synthesize the spectroscopic information.

PCA in non-pathological bone enabled us to distinguish the main bone components: proteins (mainly collagen), carbonates and phosphates (bioapatite). The same analytical procedure was applied to collagen observing two main post-mortem changes: a preferential loss of  $\alpha$ -helix with a residual increment in carbohydrates, and a secondary process related to the damage of  $\beta$ -sheets. Little changes in protein composition have been found in pathological bone with respect to non-affected (from the same individual); however, a preferential increase in carbonate rather than phosphate was detected. Our results show the potential of FTIR to explore skeletal structure and composition. The implications in the understanding of bone remodeling during chronic diseases encourage future studies.

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### Exploring taxonomic and dietary signals in Paromomyidae (Plesiadapiformes, Primates) using 3D dental topographic metrics

SERGI LÓPEZ-TORRES<sup>1</sup>, KEEGAN R. SELIG<sup>1</sup>, KRISTEN A. PRUFROCK<sup>2</sup>, DERRICK LIN<sup>1</sup> and MARY T. SILCOX<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Toronto Scarborough, <sup>2</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University

Plesiadapiformes, appearing near the Cretaceous-Paleogene boundary, represent the first primate radiation and show a diverse array of tooth morphologies. Dental topographic metrics provide quantitative data on occlusal surface shape. We used three metrics, Dirichlet normal energy (DNE), relief index (RFI), and 3D orientation patch count rotated (3D OPCR), to assess changes in the morphology of lower fourth premolars (p4) and lower second molars (m2) in a taxonomically broad sample of one family of plesiadapiformes, Paromomyidae, stretching more than 15 million years.

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Our results indicate that paromomyids occupied a more diverse range of dietary categories than suspected. Whereas RFI values calculated for *Ignacius graybullianus* suggest it was frugivorous (as expected), other species appear as omnivores, with *Phenacolemur willwoodensis* having values that indicate more insectivory. The DNE values are consistent with this picture.

RFI and DNE values also show taxonomic signals. RFI values reflect the hypothesized evolution of *Phenacolemur praecox* into *Phenacolemur fortior*, allowing for quantification of the shift from a higher to a lower-crowned p4 morphology. Additionally, markedly different RFI values in m2 and p4, and contrasting DNE values in m2 reflect morphological differences between *Phenacolemur simonsi* and *P. willwoodensis*, suggesting that *P. willwoodensis* was more insectivorous, and supporting the inference that they were distinct species, even though they are similar in size and from the same time and place (Early Eocene, Wyoming).

These results suggest that dental topographic metrics are informative to the study of paromomyids for both dietary categorization and distinction of species at a fine taxonomic level.

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### Pairing Feeding Observations with Stable Isotope Data from Bonobo (*Pan paniscus*) Fecal Samples from the Lomako Nature Reserve, Democratic Republic of the Congo

JAMES E. LOUDON<sup>1</sup>, HEATHER M. KIMEL<sup>1</sup>, MICHEL T. WALLER<sup>2</sup>, MONICA L. WAKEFIELD<sup>3</sup>, ALEXANA HICKMOTT<sup>4</sup>, FRANCIS J. WHITE<sup>4</sup> and MATT SPONHEIMER<sup>5</sup>

<sup>1</sup>Department of Anthropology, East Carolina University, <sup>2</sup>Department of World Languages and Cultures, Central Oregon Community College, <sup>3</sup>Department of Sociology, Anthropology, and Philosophy, Northern Kentucky University, <sup>4</sup>Department of Anthropology, University of Oregon, <sup>5</sup>Department of Anthropology, University of Colorado, Boulder

Stable isotope analysis has become a common tool for investigating the dietary patterns of extinct and extant primates including *Pan*. Here, we present  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data from 57 bonobo (*Pan paniscus*) fecal samples collected from the Iyema community in the Lomako Forest, Democratic Republic of the Congo. To provide contextual information we present stable isotope data from Lomako's plants. In comparison to individuals from fifteen *Pan* sites sampled across Africa (and after sample type correction), the Lomako bonobos exhibit the lowest  $\delta^{13}\text{C}$  values ( $-29.9 \pm 0.5\text{‰}$ ) and have high  $\delta^{15}\text{N}$  values ( $7.8 \pm 0.6\text{‰}$ ), although both are comparable to values of bonobos from LuiKotale. The Lomako

plants yield among the lowest  $\delta^{13}\text{C}$  values ( $-32.0 \pm 4.0\text{‰}$ ) reported anywhere. This is as expected as Lomako is an evergreen forest with a continuous forest canopy and thick undergrowth resulting in a strong canopy effect. Some of the lowest  $\delta^{13}\text{C}$  values from plants were collected from swamps at the edges of the Lomako and Yekokora Rivers. Within the primary forest, the lowest  $\delta^{13}\text{C}$  values ( $-36.8 \pm 2.9\text{‰}$ ) were from plants on the forest floor. Observations of the Lomako bonobos have revealed their reliance on swamp plants and terrestrial herbaceous vegetation, and this would also be predicted from the bonobo's low  $\delta^{13}\text{C}$  fecal values. This provides further evidence that stable isotopes may aid in determining the diets and habitat of extant primates.

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### Geochronology and palaeoecological implications of new orangutan-bearing fossil deposits from the Padang Highlands, western Sumatra

JULIEN LOUYS<sup>1</sup>, GILBERT J. PRICE<sup>2</sup>, JAHHI ZAIM<sup>3</sup>, YAN RIZAL<sup>3</sup>, WAHYU D. SANTOSO<sup>3</sup> and AGUS TRIHASCARYO<sup>3</sup>

<sup>1</sup>Department of Archaeology and Natural History, The Australian National University, <sup>2</sup>School of Earth Sciences, The University of Queensland, <sup>3</sup>Geology Study Program, Institut Teknologi Bandung

The Padang Highlands of western Sumatra host the only Pleistocene orangutan records from Sumatra. Sites excavated by Dubois in the late nineteenth century have been our only source of information on the ecological history and palaeobiology of orangutans on the island. However, these sites have been plagued by unreliable locality data and poor geochronological resolution. Here, we present two new orangutan-bearing deposits from caves in the region. Ngalau Sampit is a breccia deposit consisting largely of isolated teeth, although unusually for Southeast Asia, a partial cranial of an ungulate is preserved. U-series dating of a capping flowstone has produced an age of  $91.2 \pm 0.4$  ka. This minimum age is supported by dates of  $83.3 \pm 4.9$  ka for a calcite-filled vugh within the breccia. Ngalau Gupin preserves no datable flowstone; however, U-series dating of a *Tapirus* molar has produced a minimum age of  $\sim 42$  ka. On the basis of  $^{230}\text{Th}$  age and U-concentration profiling, the tooth appears to have taken up U rapidly following burial, with the resulting ages likely approximating the true age of the tooth. Ngalau Gupin hosts a diverse fauna including elephants, tigers, bovids, cervids, rhinos, as well as the first Pleistocene record of a civet for Sumatra. These sites, in conjunction with data from Dubois' original excavations, suggest that rainforest conditions persisted in

western Sumatra throughout the Middle and Late Pleistocene. Of particular interest, we demonstrate the continued presence of orangutans in the Padang Highlands from before and after the late Quaternary Toba super-eruption.

Funding kindly provided by the Leakey Foundation and the Research School of Asia and the Pacific, The Australian National University

### Effects of Social Transition on Health at Tumulaca la Chimba, Peru

SHANNON A. LOWMAN, BETHANY TURNER and NICOLA SHARRATT

Anthropology, Georgia State University

This study examines the relationship between significant cultural change and systemic stress between two groups from the site of Tumulaca la Chimba in the Moquegua Valley of Peru. The decline of the Tiwanaku state circa AD 1000 ushered in a period known as the terminal Middle Horizon (AD 1000-1250); archaeological evidence indicates a continuation of Tiwanaku influence during this period despite increasing political fragmentation. In contrast, the subsequent Late Intermediate Period (AD 1250-1450) appears to have been characterized by a marked shift in material culture and ceremonial architecture suggesting population replacement throughout the Moquegua Valley. This study therefore seeks to better understand the effects of this transition on the health of valley residents through a comparison of osteological data between individuals associated with the terminal Middle Horizon (N=20) and with the Late Intermediate Period (N=23). Frequencies of porotic hyperostosis, cribra orbitalia, dental pathological conditions, and occupational stress markers were recorded for each individual, coupled with existing estimates of age-at-death and sex. Preliminary results reveal significant differences in age and sex distributions and in dental and skeletal pathologies between the two samples, suggesting an increase in fertility during the terminal Middle Horizon. Frequencies of most pathological conditions are also greater in the terminal Middle Horizon, suggesting a heavier burden of nutritional deficiency and/or infection in childhood. These results provide valuable insights into this transitional period, and contribute to further understanding shifts in subsistence and demographics resulting from major social and political transition in the Andes.

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### The diet of *Homo antecessor*

MARINA LOZANO<sup>1,2</sup>, ALEJANDRO ROMERO<sup>3</sup>, JOSÉ-MARÍA BERMÚDEZ DE CASTRO<sup>4,5</sup>, EUDALD

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CARBONELL<sup>1,2</sup>, JUAN-LUIS ARSUAGA<sup>6,7</sup> and ALEJANDRO PÉREZ-PÉREZ<sup>8</sup>

<sup>1</sup>Paleoanthropology, IPHES (Spain), <sup>2</sup>Prehistory Area, URV (Spain), <sup>3</sup>Biotechnology, University of Alicante (Spain), <sup>4</sup>Paleoanthropology, CENIEH (Spain), <sup>5</sup>Anthropology, UCL (UK), <sup>6</sup>Evolución y Comportamiento Humanos, UCM-ISCIII (Spain), <sup>7</sup>Paleontology, UCM (Spain), <sup>8</sup>Evolutionary Biology, Ecology and Environmental Sciences, UB (Spain)

The diet of the earliest inhabitants of Europe has been previously inferred from archaeological evidence. However, the effects of dietary preferences on teeth remain unknown. Here, we report a novel approach through quantitative analysis of buccal microwear on cheek teeth in well-documented Gran Dolina-TD6 Atapuerca (Burgos, Spain) hominins (~0.8 million years ago), since microwear on non-working molar surfaces reflects the physical properties of chewed foodstuffs and long-term trends in dietary signals.

Buccal-microwear was examined with scanning microscopy from high-resolution molar crown impression replicas. Scratch density and length (in micrometers) were measured at 100x magnification in well-preserved enamel facets, preferably under protoconid cusp tips. Results showed that early Atapuerca hominins show a higher abraded scratch pattern compared with Sima de los Huesos and Neanderthals hominins from Iberian Peninsula.

The lack of evidence in the use of fire in the TD6 level indicated that non-thermal hard and brittle raw foods increased the abrasiveness of the diet. In basis to this unique dental microwear pattern found, we suggest that *Homo antecessor* was specialized in the ingestion of fracture-resistant foodstuffs such as Underground Storage Organs (USOs) and scavenged or hunted gritty meat resources. This mechanically-demanding dietary regimen would have required strong bite force production. The microwear density reduction in Middle Pleistocene populations suggest differences in food mechanical properties linked to more advanced tool technologies.

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### Triangulating Weaning in Wild Geladas (*Theropithecus gelada*) using Observational, Isotopic, and Gut microbial Evidence

AMY LU<sup>1</sup>, LAURIE J. REITSEMA<sup>2</sup>, JACINTA C. BEEHNER<sup>3,4</sup>, THORE J. BERGMAN<sup>4</sup> and NOAH SNYDER-MACKLER<sup>5</sup>

<sup>1</sup>Anthropology, Stony Brook University, <sup>2</sup>Anthropology, University of Georgia, Athens, <sup>3</sup>Anthropology, University of Michigan, <sup>4</sup>Psychology, University of Michigan, <sup>5</sup>Evolutionary Anthropology, Duke University

Although infant nutritional independence is an important mammalian life history milestone, age at weaning has been notoriously difficult to pinpoint in wild populations. Here we use observational data on maternal resumption of cycling and infant nursing in conjunction with cross-sectional data on fecal C:N elemental ratios and the infant gut microbiome to identify weaning in a wild primate (*Theropithecus gelada*, Simen Mountains National Park, Ethiopia). Data on post-partum sex skin swellings indicate that females resume cycling when infants reach 19 mos of age (18.6 ± 3.3 mos; N=32). However, behavioral data suggests that nursing ceases 5 months later (23.3 ± 4.3 mos; N=30). Interestingly, a quadratic plateau model fit to microbial data (N=44 mother-infant pairs) indicates that infant microbial communities resemble that of adults at 19 mos of age (18.8 mos, r<sup>2</sup>=0.81), close to infant's age at mother's first swelling. In addition, C:N ratios, which reflect the amount of grass to milk in an infant's diet, resembles adults even earlier, at 14 months of age (13.9 mos, r<sup>2</sup>=0.74; N=71 pairs). Taken together, these results suggest that early dietary transitions in wild geladas occur prior to the termination of behavioral nursing. What remains to be seen is whether such measures are inter-correlated on an individual level. Moreover, the lag time between swelling-, microbiome-, and elemental-based measures of independence on the one hand, and behavioral nursing cessation on the other, suggests that true nursing and "comfort nursing" should be considered separately when evaluating how early maternal investment influences offspring developmental outcomes.

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### External Auditory Exostoses and their Relationship to Aquatic Activities on Santa Cruz and San Miguel Islands, California

BRITTANY M. LUCERO

Centre for Anatomy and Human Identification, University of Dundee, Scotland

Anthropologists are often drawn to island-based research, as islands provide a geographically isolated 'lab' in which to study species exhibiting unique adaptations. Island species often evolve to become larger or smaller than their mainland counterparts. Species that reside on the California Channel Islands are no exception to the 'island rule'. The miniature Channel Islands Fox (*Urocyon littoralis*) and extinct Channel Islands 'pygmy' mammoth (*Mammuthus exilis*) exemplify insular dwarfism as a natural response to a downsized environment.

While non-human island adaptations are well studied, primate-based biological phenomena are comparatively poorly researched. This study

analyzes prehistoric individuals from the Channel Islands exhibiting external auditory exostoses (EAE), a condition found largely in coastal populations. EAE are benign ear growths largely thought to be caused by cold-water exposure. According to previous studies and field notes, exostoses were common within collections from the Northern Channel Islands and may be indicative of subtidal diving for marine resources.

This study analyzed the prevalence of EAE within a collection of prehistoric remains from Santa Cruz and San Miguel Islands. Presence and severity of bone growths were recorded in each individual. EAE were found in three adult male crania, and more often in left than right meatuses. Only 4.38% of individuals exhibited EAE, significantly fewer than those previously observed by Kennedy (1985) and Kuzminsky (2016) on the Northern Channel Islands. Though these results do not provide strong support for subtidal diving, additional osteological research would allow for a more accurate reevaluation of subtidal diving theories.

### Paleoenvironments and mammalian fauna of the early Miocene fossil site at Buluk, Kenya

WILLIAM E. LUKENS<sup>1</sup>, DANIEL J. PEPPE<sup>1</sup>, ELLIS LOCKE<sup>2</sup>, ELLEN MILLER<sup>3</sup>, ALAN L. DEINO<sup>4</sup>, KENNEDY O. OGINGA<sup>1</sup> and ISAIAH NENGO<sup>5</sup>

<sup>1</sup>Geology Department, Baylor University, <sup>2</sup>Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Department of Anthropology, Wake Forest University, <sup>4</sup>Berkeley Geochronology Center, Berkeley Geochronology Center, <sup>5</sup>Anthropology Department, De Anza College

The Buluk fossil site in northern Kenya is a notable early Miocene locality that preserves remains of primitive primates, including the stem cercopithecoid *Noropithecus* and the stem hominoid *Afropithecus*. Buluk also serves as a key reference site for many other early Miocene faunal constituents (e.g. carnivorans, tragulids, suids, giraffoids, stem pecorans, rhinocerotids, and proboscidiens); however, the paleoenvironment of the Buluk fauna has been little studied. Here we present the results of recent geological and paleontological fieldwork, including a revised faunal list and detailed paleoenvironmental analysis of the site.

The depositional environment for the fossil mammals at Buluk primarily consisted of a meandering river complex with associated floodplain paleosols and channel sandstones. In general, the paleosols have features that indicate subhumid to semiarid, seasonal paleoclimate. The fossils are recovered from gravel lag deposits at the base of river channels, suggesting potential taphonomic bias towards larger anatomical elements and taxa. Localized basalt flows occasionally blocked fluvial drainages, resulting in

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short-lived (non-fossiliferous) lacustrine environments. An airfall tuff caps the stratigraphic succession.

The initial paleoenvironmental and paleoclimatic reconstruction of Buluk is similar to several other early Miocene fossil sites in East Africa (e.g., Moroto, Kalodirr, Morourot, Karungu and some intervals at Rusinga). This suggests that disparities in faunal assemblages among the localities is unlikely to have been driven by large scale environmental differences, but instead are the result of subtle microhabitat features, taphonomic biases, biogeographic variation, and/or faunal turnover in the early Miocene.

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### The Center on American Indian and Alaska Native Genomics Research: Engaging Ethical, Legal, and Social Issues

JUSTIN LUND<sup>1</sup>, SCOTT KETCHUM<sup>1</sup>, PAUL SPICER<sup>1</sup>, AMANDA COBB-GREETHAM<sup>2</sup>, VANESSA HIRATSUKA<sup>3</sup> and CECIL M. LEWIS<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Oklahoma, <sup>2</sup>Native American Studies, University of Oklahoma, <sup>3</sup>Research Department, Southcentral Foundation

American Indian and Alaska Native concerns about genomic research have been foundational in ethical, legal, and social implications (ELSI) scholarship; many of these issues remain unresolved. This center seeks to make progress in and with tribal communities with the aim of articulating the possible ways in which genomic research can and should proceed that is best suited to those communities. The goals of the center include 1) developing a transdisciplinary team on the ethical, legal, and social implications of genomic knowledge for American Indian and Alaska Native communities, 2) building a consortium of tribal and community-based institutions to conduct culturally grounded comparative research in this area, and 3) creating an integrated and sustainable educational program for community members. To date the center has established an interdisciplinary team of faculty from Anthropology, Communication, Genetics, Law, and Native American Studies; built consortium of research partners ranging from Alaska to Oklahoma; conducted preliminary research to identify information needs and interests in communities; led a scoping review with regard to best practices for community engagement on genomics; and developed a training program for native students at the University of Oklahoma. This poster focuses on lessons learned and opportunities for future work utilizing this infrastructure.

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### Internal Nasal Morphology of *Rooneyia viejaensis*: Implications for Crown Primate Olfactory System Anatomy

INGRID K. LUNDEEN and E. CHRISTOPHER KIRK  
Anthropology, University of Texas

Extant haplorhines exhibit reductions in nasal cavity complexity. Comparatively, the anatomy of the nasal cavity in strepsirrhines is suggested to be plesiomorphic for crown primates. Direct observations of the nasal cavity in fossil primates have been limited by (1)rarity of specimens preserving internal bony structures and (2)low resolution of CT scans. Here we rely on recent advances in CT resolution to present a detailed comparative study of internal nasal anatomy in *Rooneyia viejaensis*, a Duchesnean primate from West Texas represented by a well-preserved cranium retaining intact bony turbinals. This study reveals *Rooneyia* has four anteroposteriorly-compressed, bullar-shaped ethmoturbinals, similar in number and shape to strepsirrhines. In contrast, tarsiers have two/three bullar ethmoturbinals and anthropoids have one/two scrolled/bullar ethmoturbinals. *Rooneyia* further differs from haplorhines in lacking mediolateral compression of the ethmoturbinals. *Rooneyia* preserves a laminar nasoturbinal similar in shape to the nasoturbinals of cheirogaleids. Strepsirrhines and small-to-medium sized platyrrhines have a nasoturbinal, absent in large-bodied anthropoids. Two frontoturbinals are present in non-primate euarchontans, while strepsirrhines only have one. Frontoturbinals are entirely lost in haplorhines. *Rooneyia* preserves one well-developed and one reduced frontoturbinal, suggesting a primitive primate condition of two frontoturbinals, as in living, non-primate euarchontans. The retention of these olfactory structures, which in life are partially covered in olfactory epithelium, suggests that olfactory cues were important in the sensory ecology of *Rooneyia*. It is also clear that *Rooneyia* lacked the derived reduction of nasal cavity complexity shared by living haplorhines, providing further evidence that *Rooneyia* is not a crown haplorhine.

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### Cultural and biological pathways of transmission among post-contact Native Americans on the High Plains

STEPHEN J. LYCETT<sup>1</sup> and NOREEN VON CRAMON-TAUBADEL<sup>2</sup>

<sup>1</sup>Department of Anthropology, University at Buffalo, SUNY, <sup>2</sup>Department of Anthropology, University at Buffalo, SUNY

Investigating the transmission of both cultural and genetic traits among human populations has major implications for understanding potential links between history, biological, and cultural variation. Direct investigations of such

combined dynamics are, however, relatively rare, partly because of difficulties in simultaneously obtaining both genetic and cultural data for populations of interest. Understanding such issues in 19th century, post-contact Native Americans on the High Plains is especially challenging given the historical character of these populations, the known complexity of dynamics in operation, and the difficulty of determining genetic patterns in historical populations for whom, even today, such data are rare. Here, using principles and methods from population genetics, we analyze both cultural and biometric data within the same framework to investigate pathways of transmission within these famous historical populations. We use biometric (cephalometric) data collected under the direction of Franz Boas from communities penecontemporaneous with the classic equestrian bison-hunters as a proxy for genetic variation. Our analyses identify that both gene flow and "culture flow" among populations of bison hunters on the Great Plains was primarily mediated by geography, fitting a model of isolation-by-distance. Moreover, these cultural and biological data indicate that such admixture largely overrode the prior millennia of cultural and genetic histories of these populations, as measured by language. Ultimately, these analyses demonstrate that the unique historical factors that converged to create the bison-hunting communities on the Great Plains led to a genuine biological and cultural "melting pot" from a linguistically and historically diverse set of indigenous populations.

### The role of primate entomophagy in niche partitioning and species coexistence: a molecular case study from Kibale National Park (KNP), Uganda

MARTHA M. LYKE<sup>1</sup>, ANTHONY DI FIORE<sup>2</sup>, NOAH FIERER<sup>3</sup>, ANNE A. MADDEN<sup>4</sup> and JOANNA E. LAMBERT<sup>5</sup>

<sup>1</sup>Anthropology, University of Texas at San Antonio, <sup>2</sup>Anthropology, University of Texas at Austin, <sup>3</sup>Ecology and Evolutionary Biology, University of Colorado Boulder, <sup>4</sup>Biological Sciences, North Carolina State University, <sup>5</sup>Anthropology, University of Colorado Boulder

Entomophagy is a significant though largely unexplored component of human and nonhuman primate diets. While few primate species are obligate insectivores, many are omnivores that habitually consume insects. Because insect intake is difficult to observe, gaining a complete understanding of entomophagy has been challenging. However, advances in genetic methods have made insect prey identification more practical, allowing for the evaluation of explicit hypotheses regarding the role of insects in primate community ecology. Here, we use next-generation sequencing to identify insects from fecal DNA to assess variation in insectivory by sympatric guenons inhabiting KNP. We test

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the hypothesis that variation in entomophagy facilitates niche differentiation and coexistence among closely related species with high dietary overlap. We collected 233 fecal samples (July – December, 2015) from redtail (*Cercopithecus ascanius*; n=118) and blue monkeys (*C. mitis*; n=115) and used high-throughput sequencing with tagged markers to identify arthropod taxa. Of 233 samples, arthropod DNA was detected in 221 (redtails n=115; blues n=106). A total of 69 arthropod families (15 orders) were identified. Redtails consumed insects from 55 families, of which 12 (21.8%) were absent from blue monkey samples. Blue monkeys consumed insects from 57 families, of which 14 (24.6%) were absent from redtail samples. These results indicate that while overlap exists in the insect portion of their diets, 20-25% of taxa consumed are unique to each group, suggesting that variation in entomophagy can be an important mechanism in decreasing niche overlap and facilitating coexistence among closely related species occupying the same feeding guild.

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### Behaviors, Badges, Bans, and Babies: Religious Commitment Signaling and Unwed Motherhood in American Samoa

CHRISTOPHER D. LYNN<sup>1</sup> and MICHAELA E. HOWELLS<sup>2,3</sup>

<sup>1</sup>Anthropology, University of Alabama, <sup>2</sup>Anthropology, University of North Carolina Wilmington, <sup>3</sup>Anthropology, University of Colorado Boulder

Religious-commitment signaling research has focused on signs that promote cooperation, with less attention paid to negative signaling. We examine unwed motherhood in American Samoa as a negative religious signal with multi-generational costs. Religious-commitment signaling is an extension of evolutionary signaling theory, applied to group-level cultural behavior that influences individual wellbeing via positive and negative feedback. Cross-culturally, religious-commitment signaling is intensified by environmental stress. Religious signaling through “hard-to-fake” signs of commitment (specific behaviors, badges, and obedience to bans) is thought to indicate willingness to cooperate with a religious group for a variety of benefits to deal with such stress. Thus, success in signaling should correspond to proximal indicators of wellbeing. Our previous research in the continental US supports this model with regard to positive signaling and stress biomarkers. American Samoa provides a better case study, as it is a developing country characterized by evangelical Christianity and a chief-dominated hierarchical infrastructure. Commitment behaviors and badges are highly ritualized—for instance, elaborate weddings are expected but costly. Low-ranking women incur significant marital delays while families raise

money. Premarital sex is a common Christian ban but harder to avoid in American Samoa due to these extended betrothals and more difficult to hide because of limited family planning resources. Nevertheless, unwed mothers are ostracized by church communities, increasing stress load for low-ranking women. Though stress was not directly linked, we found a positive association between maternal social status and neonate size in American Samoa ( $p < .05$ ). This suggests that religious-commitment signaling may have long-term, multigenerational consequences.

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### Humans of Anthropology Teaching Collections: Life-histories of Body Donors

OLHA LYSA and KATE PECHENKINA  
Anthropology, Queens College CUNY

In this study, we examine the human skeletal remains that comprise the teaching collections of CUNY Anthropology departments, in order to reconstruct life histories of these individuals. Departmental records indicate that the overwhelming majority of these skeletons were imported from South and East Asia during the late 20<sup>th</sup> century. We examined pathological lesions in the crania and postcrania, including oral health, of approximately 80 adult and 10 subadult individuals and observed unusually high rates of lesions indicative of juvenile stress, growth arrest episodes, malnutrition, osteoarthritis, and healed fractures. The high frequencies of pathological changes in the skeletons are consistent with low socioeconomic status of 20<sup>th</sup> century body donors. In addition, specimens with certain pathological features and disease were specifically selected to showcase and teach the students about the different pathological changes that can be observed on the human skeleton, which could also be responsible for a disproportionately high frequencies of lesions observed. We also note overrepresentation of males in these collections. Despite overall male morphology, crania display weak development of temporalis and masseter entheses, suggesting soft highly processed diet. High frequencies of carious lesions, antemortem tooth loss, and periodontal disease in these individuals indicate limited access to dentists and oral hygienists, poor oral hygiene, and highly processed carbohydrate rich cariogenic diet. We test several hypotheses explaining the observed bias against females, including different mortality profiles, especially due to geo political conflicts and gender-specific cultural practices.

### Differences in Endocrine Fluctuations between Geriatric *Pan troglodytes* and *Homo Sapiens*

KENTON H. MACDOWELL<sup>1</sup>, CHRISTINA T. CLOUTIER BARBOUR<sup>2</sup> and DOUGLAS C. BROADFIELD<sup>3</sup>

<sup>1</sup>Center for Complex Systems and Brain Sciences, Florida Atlantic University, <sup>2</sup>Department of Anthropology, University of Utah, <sup>3</sup>Cell Biology, Miller School of Medicine, University of Miami

Chimpanzees provide an apt analogy on which to model the life history of the early human lineage. Particularly, humans and chimpanzees seem to experience analogous reproductive senescence, with oldest ages at parturition generally coinciding. However, the time-course of changes in reproductive hormone levels in female chimpanzees is comparatively sparsely researched. We assess the hormone levels of a geriatric (aged >49 years; LM) chimpanzee in comparison with three younger controls aged 14, 23, and 40 years (JA, TO, CI, respectively). Estrone conjugates (E1C), pregnanediol-3-glucuronide (PdG), and luteinizing hormone (LH) were assessed from urine over a total of three months. All were markedly lower in LM, and their distributions differed significantly between LM and any of the other chimpanzees, with the exception of E1C in CI, who it was later discovered had health complications at the time. Trigonometric regression of LH on time yielded significant coefficients at  $\hat{t} \pm 5\%$  for TO ( $p = 0.0411$ ) and at  $\hat{t} \pm 10\%$  for LM ( $p = 0.0556$ ). Thus, LM is experiencing some smaller magnitude fluctuations in LH. The coefficients of variation for LH of LM, JA, and TO were 0.7020, 0.7764, and 0.8546, indicating LM's LH levels fluctuated 7 and 15 percentage points less than JA's and TO's, respectively. This is in contrast to post-menopausal human females in whom LH is elevated and E1C and PdG are depressed. Thus, reproductive senescence in chimpanzees is associated with a pattern of hormonal changes, but there are differences in these patterns between humans and chimpanzees that warrant further investigation.

### Maternal Effects on the Development of Sex Differences in Sociality among Wild Chimpanzees (*Pan troglodytes schweinfurthii*)

ZARIN MACHANDA<sup>1</sup>, MELISSA EMERY THOMPSON<sup>2</sup>, EMILY OTALI<sup>3</sup>, MARTIN N. MULLER<sup>2</sup> and RICHARD W. WRANGHAM<sup>4</sup>

<sup>1</sup>Anthropology, Tufts University, <sup>2</sup>Anthropology, University of New Mexico, <sup>3</sup>Kibale Chimpanzee Project, Makerere University Biological Field Station, <sup>4</sup>Human Evolutionary Biology, Harvard University

Among adult chimpanzees, males are more gregarious than females. This pattern is likely the result of (1) greater benefits of cooperation for males and (2) a flexible fission-fusion dynamic that allows females to reduce feeding

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competition by foraging alone. It has been suggested that mothers differentially influence the socialization of male and female offspring in order to prepare offspring for these different adult social environments. To examine these patterns, we used 27 years of data (1988-2015) from 37 subadult males and 40 subadult females living in the Kanyawara community of chimpanzees in Kibale National Park, Uganda. We tested the hypothesis mothers of sons differentially associate with adult males compared to mothers of daughters. We found that mothers of young infant (0-1 year old) sons spent more time in parties with adult males compared to when they were the mother of a young infant daughter ( $p=0.006$ ). This pattern was consistent for 7 of the 10 females that had both sons and daughters during the study period. Maternal rank was also a significant predictor of association with adult males ( $p=0.05$ ) such that high ranking mothers spent less time in association with adult males. This is inconsistent with our prediction given that high ranking females should suffer less feeding competition in large mixed-sex parties compared to low-ranking females. This suggests that low-ranking mothers of young infants may be associating in parties with adult males for different reasons than the high-ranking mothers of young infants.

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### Identifying the effects of diverse ecological and biological variability in Bronze-Iron Age Inner Asian steppe populations

MICHELLE MACHICEK and JACQUELINE T. ENG  
Anthropology, Western Michigan University

The Inner Asian steppe region has long been characterized by periods of major subsistence shifts among steppe populations, with notably, the development of nomadic pastoralism. However, recent research has drawn attention to the diversity in ecological zones occupied by steppe groups, as well as the mixed economic practices they engaged in. This study uses multiple methods combining isotopic and osteological analyses to explore the impact of ecological diversity among samples of human remains, including the potential variation in the biological imprint of stress and disease. Individuals from three sites located in northern and central Mongolia ( $n=68$ ) and four sites from north-central to northwestern China ( $n=37$ ) are analyzed for stable isotope information on dietary trends across a wide and diverse geographic swath of the Inner Asian steppe that span the late Bronze Age (c. 1800-600 BC) to early Iron Age (c. 500-AD 100).

Data indicate an extensive range of variation in  $\delta^{13}\text{C}$  (-18.37 to -12.38) and  $\delta^{15}\text{N}$  (9.75 to 15.36) isotopic signatures. These results are reflective

of the inhabitation of arid to more temperate environments, as well as variation in dietary intake across more mobile and semi-sedentary groups. These samples are also assessed for bioarchaeological markers to provide osteobiographic details of the lived experiences of these individuals. Our study generates not only an isotopic dietary profile of steppe groups, but also a personalized perspective of adolescence to older adult age among them, which includes instances of trauma from interpersonal conflict, disease, and childhood stress.

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### Developmental Perspectives on the Hominid Sacroiliac Complex

ALLISON L. MACHNICKI<sup>1</sup>, LINDA B. SPURLOCK<sup>2</sup>, STEVEN M. HRYCAJ<sup>3</sup>, DENEEN M. WELLIK<sup>3</sup>, C. OWEN LOVEJOY<sup>2</sup> and PHILIP L. RENO<sup>1</sup>

<sup>1</sup>Anthropology, Pennsylvania State University, <sup>2</sup>Anthropology, Kent State University, <sup>3</sup>Internal Medicine, Division of Molecular Medicine & Genetics, University of Michigan Medical Center

The primate iliosacral complex varies in total number of sacral vertebrae, the number of sacral segments contributing to the sacroiliac (SI) joint, and the position of the SI joint within the pelvis. The number of segments within each pre-caudal vertebral region varies within species, and this variability can occur due to homeotic transformations via *Hox* genes within and between the succeeding somatic levels of the column. To answer questions surrounding variability of sacrum length and the size and placement of the SI joint, we collected metric data from primate sacra and pelves and used mouse models to interpret potential genetic mechanisms underlying variation in the primate iliosacral complex. *Hoxd9*<sup>-/-</sup> and *Hoxd13*<sup>-/-</sup> mutant mice exhibit longer sacra by virtue of a transformation of their first caudal into a sacral vertebra. *Hoxa11*<sup>-/-</sup> and *Hoxd11*<sup>-/-</sup> mice have sacral to lumbar transformations shortening the sacrum. In *Hoxd11*<sup>-/-</sup> mice, the pelvis is shifted caudally by half a vertebral level, shortening the amount of ilium cranial to the sacrum relative to the wild type. These pelvic shifts are an important observation for hominid evolution since there is variability in the height of the ilium above the sacrum and placement of the SI joint within and between hominoids. We found monkeys, gibbons, and humans to have relatively stable lumbar and sacral counts whereas great apes do not. This may imply stabilizing selection in monkeys, gibbons, and humans but possibly recent directional selection on a reduced lumbar region and longer sacrum in great apes.

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### Adaptations in the Upper Limb of *Australopithecus*

MARISA E. MACIAS<sup>1</sup> and MARK GRABOWSKI<sup>1,2,3</sup>

<sup>1</sup>Division of Anthropology, American Museum of Natural History, <sup>2</sup>Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biosciences, University of Oslo, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University

Over the course of hominin evolution, the forelimb transformed from what was primarily a climbing and suspensory apparatus to one more suited to making and using tools, although the exact nature and timing of this transition remains unclear. Nowhere is this uncertainty more evident than in the long-standing debate about arboreality in members of the genus *Australopithecus* and the interpretation of primitive, ape-like traits in the upper limb. Are they simply nonfunctional ancestral traits inherited from a climbing ancestor, or were these traits retained because they were still functionally important for climbing? Here we test the hypothesis that directional selection on individual aspects of morphology was responsible for the functional differences observed among an ape-like ancestor and the fossil taxa *Australopithecus afarensis* and *A. sediba*. We use covariance among traits and the differences between relatively complete fossils to estimate the net selection pressures that drove these transitions in hominin upper limb evolution. Our preliminary findings suggest that natural selection for arboreality was not a factor in the shift from an ape-like ancestor to *Australopithecus afarensis*, but directional selection for arboreality did impact several upper limb traits in the shift from *A. afarensis* to *A. sediba*. While some traits hypothesized to play functional roles in arboreality, such as the insertion of the deltoid and phalangeal length, evolved as a direct result of natural selection, others, such as humeral head shape and overall length, likely experienced evolutionary shifts as a result of selection on other aspects of anatomy.

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### Greater variability in within-section cortical thickness among men relative to women and its effects on the accuracy of periosteally-derived cross-sectional geometry estimates

ALISON A. MACINTOSH<sup>1</sup>, COLIN N. SHAW<sup>1</sup>, TIMOTHY M. RYAN<sup>2</sup> and JAY T. STOCK<sup>1</sup>

<sup>1</sup>PAVE Research Group, Archaeology and Anthropology, University of Cambridge, Pembroke Street, Cambridge CB2 3QG, United Kingdom,

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<sup>2</sup>Department of Anthropology and Center for Quantitative Imaging, Pennsylvania State University, University Park, PA 16802, United States

Periosteally-derived cross-sectional geometric (CSG) properties have been shown to correspond strongly to true CSG properties (derived from periosteal and endosteal contours) across large sections of long bone diaphyses in pooled-sex samples, with the majority of error attributable to variation in percent cortical area (%CA). However, differences in mechanical loading and reproductive hormones between the sexes can affect relative remodeling rates at both bone contours and thus cortical thickness. The current study assesses prediction accuracy of humeral and tibial polar second moments of area ( $J$ ), polar section moduli ( $Z_p$ ), and second moments of area ( $I_{max}$ ,  $I_{min}$ ) in males and females separately. Cross-sectional images were obtained using computed tomography, and regressions were performed on mechanical properties calculated from images with a) artificially filled medullary cavities and b) true unaltered cross-sections. Prediction errors were low (<3.5%) in both sexes, and all  $R^2$  values exceeded 0.9; the largest source of error in most predictions was %CA. However, males exhibited higher prediction errors and lower  $R^2$  values than females, particularly in humeral  $J$  and  $I_{max}$ . This was attributable to their more variable cortical thickness about the cross-section, which has been shown to impact the orientation of principal axes for  $I_{max}$  and  $I_{min}$  in 'solid' cross-sections. This underestimation of male bone rigidity was small, and is not likely to affect the detection of true sex differences unless these are only marginally significant. However, results highlight the importance of accounting for the relative position of the endosteal contour in comparisons of individual values between men and women.

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### Documenting the Changing Reproductive Landscape among Shuar Females from Amazonian Ecuador

FELICIA C. MADIMENOS<sup>1</sup>, MELISSA A. LIEBERT<sup>2</sup>, SAMUEL S. URLACHER<sup>3</sup>, TARA J. CEPON-ROBINS<sup>4</sup>, THERESA E. GILDNER<sup>2</sup>, CHRISTOPHER J. HARRINGTON<sup>2</sup>, J. JOSH SNODGRASS<sup>2</sup> and LAWRENCE S. SUGIYAMA<sup>2</sup>

<sup>1</sup>Department of Anthropology, Queens College, CUNY, <sup>2</sup>Department of Anthropology, University of Oregon, <sup>3</sup>Department of Anthropology, Hunter College, CUNY, <sup>4</sup>Department of Anthropology, University of Colorado, Colorado Springs

The current study investigates secular changes in female reproduction among the indigenous Shuar from Amazonian Ecuador. Reproductive histories were collected from 450 Shuar women (ages 12 - 90 years old), including data regarding

age at menarche and first parturition, number of births, age at menopausal onset (when applicable), as well as details regarding lactation practices. Participants were separated into age categories (<20, 21-30, 31-40, 41-50, 51-60, >60 years old) so as to identify secular trends in reproductive profiles. While mean age at menarche varied minimally across age cohorts (13.1 - 13.9 years old), age at first parturition has significantly declined. Among 104 participants <20 years old, mean age at first parturition is 16.4 compared to 18-20 years old in females >21 years old ( $p < 0.001$ ). Thus, while no secular change in menarcheal age is demonstrated, a negative trend in age at first parturition is evident. Younger mothers also report a significant reduction in duration of lactation per child ( $x_{1...} = 5.6$  months), compared to older cohorts who report breastfeeding up to 12-17 months ( $p < 0.001$ ). Put simply, Shuar females are having children at younger ages and weaning infants at earlier stages of development. Because life history theory posits that organisms will face fundamental trade-offs in deciding how much time and energy is invested in growth or reproduction, secular trends in such trade-offs are to be expected. We discuss how this reproductive shift bears implications for life history trade-offs within and across generations.

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### Variation in clinical symptoms in sickle cell trait athletes: a study on genetic markers and behavioral traits

CARROLL FLANSBURG<sup>1</sup>, CHRISTINA M. BALENTINE<sup>2</sup>, RYAN W. GRIEGER<sup>3</sup>, JUSTIN LUND<sup>4</sup>, MICHELLE CIAMBELLA<sup>4</sup>, EDUARDO GONZALEZ<sup>5</sup>, DEANDRE WHITE<sup>6</sup>, ANNE C. STONE<sup>4</sup> and LORENA MADRIGAL<sup>6</sup>

<sup>1</sup>Geisinger Health System, Danville PA, <sup>2</sup>Department of Integrative Biology, University of Texas at Austin, <sup>3</sup>School of Life Sciences, Arizona State University, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University, <sup>5</sup>College of Medicine, University of South Florida, <sup>6</sup>Anthropology, University of South Florida

All athletes in division I and II in the USA are required to be tested for sickle cell trait (SCT) or to sign a written release declining the test before competing. This policy has been implemented with the idea that if a sickle cell trait athlete is aware of his/her condition, s/he and her coach will be able to take appropriate precautions. The most emphasized and effective precaution has been effective hydration, which has been said to be responsible for the US army's significant decrease in sickle-cell trait deaths. In this study we have gathered information about hydration levels, clinical symptoms and frequencies of five SNPs affecting HbF levels as well as two SNPs

affecting G6PD A- deficiency in 29 DNA samples from College Football athletes. Seventeen percent of the participants reported no symptoms associated with their SCT status while eighty-three percent of the participants reported a large number of complaints. The frequency of participants who reported having an adequate level of hydration during training was not significantly different between the group with no symptoms and the group with symptoms (Fisher's exact test  $p=0.1548$ ). These data indicate that hydration is not the main reason why some athletes suffer from SCT symptoms while others do not. In our presentation we will discuss the association between genetic markers and symptoms. The evolutionary implications of our project are questioning to what extent the heterozygote of this polymorphism is benign under conditions of physical stress.

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### Sub-seasonal oxygen isotope variations in human bone reflect changes in drinking water

COREY M. MAGGIANO<sup>1,2</sup>, CHRISTINE WHITE<sup>2</sup>, RICHARD STERN<sup>3</sup> and FRED J. LONGSTAFFE<sup>4</sup>

<sup>1</sup>Anthropology, University of West Georgia, <sup>2</sup>Anthropology, University of Western Ontario, <sup>3</sup>Earth and Atmospheric Sciences, University of Alberta, <sup>4</sup>Earth Sciences, University of Western Ontario

Oxygen isotopic variations in tooth and bone bioapatite can provide information on landscape mobility and changing climatic conditions in archaeological contexts. Bone microstructure, however, is complex and remodelled throughout life. This complexity generally prohibits extraction of chronological oxygen isotopic data from bone. Recent studies, however, have identified unexpectedly large, incremental primary bone deposits that persist well into human adulthood (the endosteal lamellar pocket, or ELP). Our current project targeted the ELP using secondary ion mass spectrometry (SIMS), and found patterned variations in oxygen isotopic composition ( $\delta^{18}O$ ). These variations were consistent across multiple tests of the same ELP deposit, and appear to indicate a decade of oscillations associated with the  $\delta^{18}O$  of summer and winter drinking water, respectively. The growth rate suggested by the  $\delta^{18}O$  variation is also consistent with other measures of primary human bone depositional rates and seems predictably affected, locally, by disruptions called LAGs (lines of arrested growth). Refinement of this technique will augment archaeological analyses of health, outsiders, migration, trade, and even distinguish in-life cohorts within skeletal assemblages. Other important applications include forensic and war-dead identification, and novel anatomical and clinical investigation of human bone growth and

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histomorphometry that will take advantage of long-term chronological stable isotopic labelling.

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### Longitudinal variation of osteon circularity in three-dimensional reconstructions of Haversian networks

ISABEL MAGGIANO<sup>1</sup>, COREY MAGGIANO<sup>1</sup>, JOHN CLEMENT<sup>2</sup>, DAVID THOMAS<sup>2</sup> and DAVID COOPER<sup>3</sup>

<sup>1</sup>Anthropology, University of West Georgia, USA,

<sup>2</sup>Melbourne Dental School, University of Melbourne, Australia, <sup>3</sup>Department of Anatomy and Cell Biology, University of Saskatchewan, Canada

Secondary osteons are a common target for quantitative analyses in skeletal histology and have been related to different strain environments as well as age and body weight. Since these osteons are roughly circular in cross-section, it is generally accepted that in three-dimensions they are cylindrical and that a circularity measure in a single cross-sectional plane can be used as an indicator of a Haversian system's spatial shape characteristics. However, detailed longitudinal reconstructions of Haversian systems are rare and to our knowledge, the degree of longitudinal variation of osteon circularity within single systems has yet to be measured. For this purpose, the present study uses 3D reconstructions of Haversian systems from synchrotron Micro-CT images to gain up to 890 circularity measurements in single Haversian systems along a 1.3 mm z-axis. Results demonstrate the statistical significance of variation in osteon circularity along its length. In addition, cross-sectional circularity changes significantly in proximity to branching events and other connections between Haversian systems, with some connections exhibiting more dramatic changes than others. Longitudinal variation in osteon circularity seen in these 3D reconstructions indicates that more information should be collected on local determinant factors for circularity measurements before they can be considered a general indicator of the three-dimensional morphological characteristics of Haversian systems.

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### Biorhythm tracks enamel thickness in humans and great apes

PATRICK MAHONEY<sup>1</sup>, JUSTYNA J. MISZKIEWICZ<sup>2</sup>, ROSIE PITFIELD<sup>1</sup>, CHRIS DETER<sup>1</sup> and DEBBIE GUATELLI-STEINBERG<sup>3</sup>

<sup>1</sup>Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent,

<sup>2</sup>School of Archaeology and Anthropology, Australian National University, <sup>3</sup>Department of Anthropology, The Ohio State University

Although evidence of a biorhythm retained in tooth enamel as Retzius periodicity (RP) was identified in the 19<sup>th</sup> century its significance for

mammalian growth and life history has only recently been discovered. This study builds upon our recent work where we hypothesised the biorhythm may have a role in enamel growth, and that its periodicity may change from deciduous to permanent teeth. Here we test this hypothesis. We compare RP between deciduous second and permanent first molars within the maxillae of four human children. We report the first RP's for deciduous teeth from modern great apes ( $n=4$ ), and compare these to new data for permanent teeth ( $n=18$ ) from these species, as well as to previously published values. Results show RP changed within the maxilla of each child, from thinner to thicker enameled molars. RP of 5 days for great ape deciduous teeth lay below the lowermost range of those from permanent teeth from modern orangutan and gorilla, and within the lowermost range of RP's from chimpanzee permanent teeth. When considered alongside our earlier reported correlation between RP and formation time, these observations provide further evidence that RP is associated with enamel growth processes in humans, and can change from deciduous to permanent teeth within an individual. Our data suggest these associations might extend to great apes. We conclude that enamel growth should be considered alongside other physiological systems when developing predictions around RP as a measure of an underlying biorhythm.

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### Middle phalanx morphology reflects postural differences of primate grooming and nail-bearing digits

STEPHANIE A. MAIOLINO

Pathology and Anatomical Sciences, University of Missouri School of Medicine, Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University

In primates, specialized digits used for grooming have unguis (keratinized structures) that project dorsally to a higher degree than do those of nail-bearing digits. Observations from microCT scans of primate feet suggest that this is facilitated by the orientation of the phalangeal shafts with respect to their distal interphalangeal (DIP) joint surfaces. This leads to a more hyper-extended posture at close-packed position. While this morphology has been quantified for distal phalanges, the current study investigates the reciprocal morphology of middle phalanges (MPs).

A 3D geometric morphometric approach was used to quantify MP morphology in 23 species, including strepsirrhines, tarsiers, and anthropoids. Eleven landmarks were taken on 37 MPs from grooming digits and 35 from nail-bearing digits ( $n=72$ ). A canonical variate analysis of Procrustes aligned coordinates showed that the distal articular facets of MPs from grooming digits are more dorsally canted than are those

of nail-bearing digits, an orientation that likely contributes to the hyper-extended posture of the DIP joint.

First, these results suggest that morphology of the MP can provide evidence for the presence of a grooming unguis in species for which no distal phalanges have yet been recovered. This is particularly useful because the presence of a grooming unguis is often accorded strong phylogenetic significance for fossil primates. Second, these findings suggest that postural differences in digits can be reflected in MP joint surfaces. Future work seeks to assess its applicability for studying the differences in joint mechanics between digits that bear claws and those that bear nails.

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### Community-based approaches to genomic research with Indigenous peoples of North America

RIPAN S. MALHI, ALYSSA C. BADER and MARY P. ROGERS

Anthropology, University of Illinois at Urbana-Champaign

Historically, indigenous communities of the Americas have been exploited by scientists, resulting in sometimes antagonistic relationships between indigenous peoples and the scientific community today. Within genomic research, this ongoing distrust has resulted in non-representative sampling from indigenous communities, a lack of scientific research specifically of interest and beneficial to indigenous communities, and underrepresentation of indigenous people as scientists. To ensure that research is conducted in an inclusive manner, biological anthropologists need to broaden the scope of what is considered scientific method and process for research involving indigenous peoples or their ancestors. Using a community-based approach, we engage with communities to conduct research that is mutually beneficial to community members and scientists, while minimizing any potential harm to participants or the communities involved in the research. We make multiple visits to the community during the course of the project to seek community input on the research design, hypotheses, results and interpretations. Prior to publication, we share manuscripts and presentations with interested community members and solicit input to express community views on the research conclusions. Lastly, we provide appropriate credit to members of the community who have made valuable intellectual or logistical contributions to the research project. Our research benefits by including indigenous views and values.

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## Evaluating the Limitations of Biological Distance Models of Gene Flow in Ancient Human Populations

ANGELA M. MALLARD<sup>1</sup>, JAMES T. WATSON<sup>2</sup> and BENJAMIN M. AUERBACH<sup>1</sup>

<sup>1</sup>Anthropology, University of Tennessee, Knoxville,

<sup>2</sup>Anthropology, University of Arizona

Anthropologists frequently use skeletal trait metrics to identify relationships between archaeological populations and within sites. Most methods for estimating biological distances model relationships by examining measures of trait mean distances and comparisons of within-group variances. Gene flow is difficult to ascertain using these methods. Studies have generally assumed that increased variances in traits over time stand as indicators of gene flow. However, such changes in variance are contextually driven by the number of groups being compared and the assumptions of the model.

In this study, we calculate relationship matrices (after Relethford and Blangero) to evaluate variance of odontometric traits of the molar occlusal surface. We examine three archaeological groups from the southwestern U.S. and northern Mexico ( $N=69$ ). Two are from the site of La Playa in Sonora, Mexico, and represent temporally and culturally separate groups of the Early Agricultural period: San Pedro phase (1600-800 B.C.) and Cienega phase (800 B.C.-A.D. 200). Grasshopper, Arizona – a Pueblo III (A.D. 1150-1300) site – is our third group. Based on craniometric studies, we expect the San Pedro phase group to exhibit evidence of gene flow. Though later and farther north, studies of architecture at Grasshopper suggest that multiple groups settled there; we anticipate higher than expected trait variance. Results indicate gene flow contributed to variance in the San Pedro sample, but, surprisingly, evidence for relative homogeneity at Grasshopper. We evaluate these results against simulated samples, and use these comparisons to explore limitations and directions for improving interpretations of gene flow between archaeological populations.

## Relationship between Reproductive status and Gut Microbial Community Composition in White-faced Capuchins (*Cebus capucinus*)

ELIZABETH K. MALLOTT<sup>1</sup>, PAUL A. GARBER<sup>2</sup>, RIPAN S. MALHI<sup>2,3</sup> and KATHERINE R. AMATO<sup>1</sup>

<sup>1</sup>Department of Anthropology, Northwestern University, <sup>2</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>3</sup>Carl R Woese Institute of Genomic Biology, University of Illinois at Urbana-Champaign

Changes in reproductive status influence nutrient requirements in female primates. The

gut microbiome may buffer changes in energy demands, with shifts in community composition allowing for increased energy uptake during pregnancy and lactation. To better understand the influence of reproductive status on the gut microbiota of primates, five adult female white-faced capuchins (*Cebus capucinus*) of varying reproductive status were followed longitudinally for 12 months at La Suerte Biological Field Station, Costa Rica. Information on activity budget and diet was collected. DNA was extracted from fecal samples collected during the observational study (total fecal samples=43, pregnant=14, lactating=10, reproductively-active=19), and the v3-v5 region of 16S rRNA was amplified. Samples were individually barcoded and sequenced on the Illumina MiSeq platform. Using the TORNADO pipeline, OTUs were identified and assigned to taxa. Overall bacterial community structure was not significantly influenced by the reproductive status of females (PERMANOVA,  $p>0.05$ ). However, individual differences in shifts in gut microbial community structure in response to changes in reproductive status and diet were evident. One female's gut microbiome was strongly related to both reproductive state (PERMANOVA,  $R^2=0.23$ ,  $p=0.014$ ) and percentage of feeding and foraging time devoted to invertebrates (PERMANOVA,  $R^2=0.19$ ,  $p=0.028$ ), while the gut microbial communities of other females ( $n=3$ ) were not influenced by reproductive status or diet. These results increase our understanding of how the gut microbiome of individual primates differentially responds to changes in nutritional demands, and the diversity of strategies primates may employ to buffer both varying food availability and nutrient requirements.

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## Histological Sectioning and Imaging of *Papio* Dentition Prior to Isotopic Sampling Permits Fine-tuned Assessments of Ages at Dietary Transitions

MAIRE MALONE<sup>1</sup>, LAURA MACLATCHY<sup>1</sup>, JOHN KINGSTON<sup>1</sup> and GARY T. SCHWARTZ<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Michigan,

<sup>2</sup>Institute of Human Origins, Arizona State University

Stable light isotope analysis of sequentially forming layers of enamel apatite permits direct assessment of dietary shifts through developmental time. Traditional serial sampling of teeth, typically by drilling into enamel at ~1mm intervals down the full crown height, often results in the intermixture of temporally distinct enamel zones. This study quantifies the extent of this intermixture.

A wild *Papio cynocephalus* M<sup>1</sup> was serially sampled using this technique, yielding four drilled samples of equal enamel volume (~5 mg) from along the crown. Histological sectioning and

imaging of the same cut face from the antimeres revealed substantial temporal overlap; enamel in each sample came from zones forming as much as 8 months apart.

Standard histological techniques were used to link each sampled area with crown formation chronology. Analysis indicates that the four samples consisted of varying mixtures of prenatal enamel, enamel from ages 0-4.5 months, and that from 4.5-16.5 months in the following percentages: Sample 1: 15%, 45%, 40%; Sample 2: 0%, 40%, 60%; Sample 3: 0%, 15%, 85%; Sample 4: 0%, 0%, 100%.

To avoid time averaging of isotopic values from enamel formed before, during, and after the presumed weaning period, we additionally report an alternative mechanical sampling strategy; a second thin section prepared from the opposing face of the tooth, will be diced using a dicing saw according to a sampling grid that follows that tooth's growth trajectory. The precision of this method will permit more meaningful interpretations of dietary shifts occurring seasonally, across development, and over evolutionary time.

*Funding for this project was provided by the University of Michigan.*

## Using the Digitized Cranial Angle Method for Ancestry Estimation in American Black, American White, and Japanese Individuals

JIRO MANABE

NA, Tokyo, Japan

The human cranium provides information regarding variation in ancestry, sex, and age, and anthropologists have been attempting to determine better methods to ascertain such information using cranial landmarks in quantitative analyses. Standard cranial measurements of linear inter-landmark distances have been commonly utilized to classify cranial and post-cranial elements, while angle variables have been less frequently used - mainly due to the inability of older methods to accurately capture angles. However, in recent years, digitizers have allowed anthropologists to easily capture xyz coordinates, including angles, which are amenable to diverse quantitative analyses. This paper examines eight mid-facial angle variables that Howells (1973) introduced. A total of 198 dry male skulls (American Black = 51; American White = 42; Japanese = 105) from the World War II era were digitized with a stylus digitizer MicroScribe® (Revware, Inc., Raleigh, NC). The eight angle variables were computed using mathematical equations in an Excel spreadsheet based on the captured xyz coordinates. Subsequently, discriminant function analyses using cross-validation were performed in the SPSS statistical software program. The results indicate that each group was correctly classified between 80% and 90% of the time using the angle variables alone, and

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the American Black individuals were classified the best at 86.3%. Accordingly, the cranial angle method serves as a robust tool in classifying the three ancestral groups using only the mid-facial region. Further, this study demonstrates the utility of the digitizer in forensic ancestry assessment based on mid-facial morphology.

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### Hip fractures and survivorship in old age: investigating trauma in the archaeological record

MADELEINE L. MANT<sup>1</sup>, RACHEL IVES<sup>2</sup>, CARLINA DE LA COVA<sup>3,4</sup> and MEGAN BRICKLEY<sup>1</sup>

<sup>1</sup>Anthropology, McMaster University, <sup>2</sup>AOC Archaeology Group, AOC Archaeology Group, <sup>3</sup>Anthropology, University of South Carolina, <sup>4</sup>African American Studies Program, University of South Carolina

Hip fractures, occurring in the femoral neck and trochanteric region, have high incidence rates in the modern Western world and are associated with high morbidity and mortality and considerable expenditure. In modern populations these fractures have been documented as increasing exponentially with age, being associated with a specific demographic group (older adults) and are frequently linked to an underlying pathology (e.g., osteoporosis or vitamin D deficiency). The rising prevalence with age may mean that hip fractures were rare occurrences in some past populations, with higher mortality in young to middle adulthood than found in developed countries today. Yet, in population samples that do demonstrate demographic longevity, there is potential to recognize age-related pathological conditions. This research analyzed the skeletal remains of 1497 adult individuals (834 males, 652 females, 11 undetermined sex) from eight post-medieval sites from England dating from the 18<sup>th</sup> and 19<sup>th</sup> centuries. Of this sample, 15 (1.0%) had fractures in the femoral neck or inter-trochanteric area: nine males, four females, and two individuals of indeterminate sex. There was an age-related trend with more individuals aged 50+ years with fractures than in other age categories. Underlying osteoporosis was potentially a complicating factor in five individuals. This paper examines the significance of these results for the wider understanding of the biological and social impacts of hip fracture in elderly individuals in the past.

### Hard food for stiffer jaws: A comparative Finite Element Analysis of different primate jaws

JORDI MARCÉ-NOGUÉ<sup>1</sup>, THOMAS A. PÜSCHEL<sup>2</sup> and THOMAS M. KAISER<sup>1</sup>

<sup>1</sup>Centrum für Naturkunde, University of Hamburg, <sup>2</sup>School of Earth and Environmental Sciences, University of Manchester

Planar biomechanical models of the mandible of 31 extant primate species –including hominoids– were investigated using Finite Element Analysis (FEA). Four different bite positions were simulated (i.e. incisive, canine, premolar and molar biting) thus obtaining von Mises stress patterns. A comparative framework was established to allow inter-species comparison, taking into account size differences, bone properties and model orientation. Pagel's  $\lambda$  statistics revealed, that our data are free of phylogenetic distortion.

Different procedures proposed to quantitatively compare FEA data obtained from dissimilar models were used combining both the stress distribution maps and the numerical values for the whole models. These procedures allow a Kruskal-wallis test to be performed with Bonferroni correction in order to perform multiple comparisons between non-normal data. Statistics were calculated for each biting scenario using the species diet categories (i.e. folivores, frugivores and omnivores) and the relative toughness of their typical ingesta (i.e. hard-food, soft-food and an intermediate group) as classifying categories.

The obtained results significantly showed that hard-food eaters exhibit stiffer jaws when compared to those primate species not particularly involved in hard object feeding. Even though the results from the diet categories comparisons were not significant, some trends are observed, showing that folivore species present the weakest jaws, while omnivores seemed to have the stiffer jaws.

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### Nearly naked apes: A survey of hair plucking among captive bonobos (*Pan paniscus*)

LINDA F. MARCHANT<sup>1</sup> and COLIN M. BRAND<sup>2</sup>

<sup>1</sup>Anthropology, Miami University, <sup>2</sup>Anthropology, University of Oregon

The appearance and condition of captive great ape pelage is often perceived as an indicator of physical and psychological well-being. When apes exhibit hair loss or indications of self or social hair plucking (a rapid jerking away of the hair shaft and follicle by the hand or mouth, often accompanied by inspection and consumption) public perception suggests the apes are experiencing stress. Other than a survey of gorilla hair

plucking, evidence of the behavior among captive great apes is absent. Here, we present the first survey of this behavior among captive bonobos (N=77) in six facilities in the US. This sample included 44 females and 33 males. We found that discounting youngsters (who are not observed to hair pluck until the age of five), 60% of individuals engaged in these patterns of behavior. Of the individuals who hair plucked, 97% engaged in social plucking, whereas 50% engaged in self plucking. In the sample, females were more likely to hair pluck than males (N=57, G=12.845, P<0.001). The extent of hair loss among hair pluckers was equally distributed among - little if any, moderate, and substantial. Excluding youngsters, there was no effect of age, rearing, body area plucked or physical setting. Observation of hair plucking was positively associated with other patterns of undesirable behavior (e.g. coprophagy, R&R). In contrast to the captive gorilla data, where 15% exhibited hair plucking, the incidence and intensity of hair plucking among captive bonobos may contribute to the discussion of the public's perception of bonobo well-being.

### Molecular evidence for *Plasmodium falciparum* malaria in 1st-4th c. A.D. southern Italy

STEPHANIE MARCINIAK<sup>1,2</sup>, TRACY L. PROWSE<sup>2</sup>, ANN HERRING<sup>2</sup>, JENNIFER KLUNK<sup>1,3</sup>, MELANIE KUCH<sup>1</sup>, ANA T. DUGGAN<sup>1,2</sup>, LUCA BONDIOLI<sup>4</sup>, EDWARD C. HOLMES<sup>5</sup> and HENDRIK N. POINAR<sup>1,2,3</sup>

<sup>1</sup>McMaster Ancient DNA Centre, McMaster University, <sup>2</sup>Department of Anthropology, McMaster University, <sup>3</sup>Department of Biology, McMaster University, <sup>4</sup>Sezione di Bioarcheologia, Museo Nazionale Preistorico Etnografico "Luigi Pigorini", <sup>5</sup>Marie Bashir Institute for Infectious Diseases and Biosecurity, The University of Sydney

Malaria is a significant historical pathogen, particularly as a scourge of ancient Rome. Although evidentiary sources (e.g., historical, epigraphic or skeletal) support malaria presence, these preclude establishing a causative species, whereas ancient DNA technology is well-positioned to do so. To investigate malaria in Imperial period Italy (1st-4th c. A.D.), we used three disparate coastal and rural localities from this time: Isola Sacra, Velia, and Vagnari. We randomly selected first or second molars from 58 adults across these cemeteries that were further prioritized to a subset of 11 specimens using metagenomic sequencing. Here we report on a mitochondrial genome capture strategy using RNA baits targeting four human and two non-human *Plasmodium* species, never before applied in the detection of malaria in ancient human skeletal remains. With this technique, we successfully recovered 50.8% of the *P. falciparum* mitochondrial genome combined from two individuals at Velia and Vagnari. Our data are supported by compelling phylogenetic evidence from 53 diverse *Plasmodium* species, where this

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ancient *P. falciparum* strain groups exclusively with representative *P. falciparum* isolates. This is the first genomic evidence that implicates this parasitic infection in adults at multiple localities in southern Italy. This presentation highlights the potential of retrieving genomic signatures of malaria from diverse archaeological assemblages, and also discusses the complexity surrounding molecular investigations of low abundance human pathogens.

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### ***Ave Imperium! Mortui te salutamus:* Bioarchaeological Research in the Roman Period Black Sea Region, Turkey**

KATHRYN E. MARKLEIN

Department of Anthropology, The Ohio State University

Bioarchaeological approaches to studies in "Romanization" have provided informative biocultural perspectives about local adaptations to imperial rule. In this study, such adaptations are examined within the rural community of OymaaĀyaç, a community annexed within the Roman Pontus (1<sup>st</sup> c. BCE through 4<sup>th</sup> c. CE). Biomarkers of stress—proxies for activity (osteoarthritis), childhood growth perturbations (linear enamel hypoplasia, LEH), and interpersonal conflict (perimortem and antemortem trauma)—were compared between the individuals in earlier multi-interment graves (N=107) and later Roman mass graves (N=71) to assess whether increased trade and cultural interactions with western provinces to this community had detrimental effects on the liminal populace, as observed in other Roman-conquered territories (e.g., Britain). Distributions of age cohorts, sexes, and biomarkers of stress were subjected to Chi-square tests to determine whether multi-interment and mass subgroups yielded significant differences. Demographic data indicated a significantly higher proportion of juveniles (below 16 years) in mass graves, while no statistical differences in adult age cohorts (16-19 years; 20-34 years; 35-49 years; and over 49 years) or sexes were observed between grave groups. Despite significant differences in LEH prevalences ( $P < 0.001$ ), no significant differences in osteoarthritis or trauma were noted between multi-interment and mass grave contexts. These results from Roman period burials at OymaaĀyaç contrast with bioarchaeological findings from western provinces, which recognize a decline in biological health associated with direct Roman rule and occupation.

*This research was funded through fellowships from the American Research Institute in Turkey and the American Schools of Oriental Research as well as an OSU Larsen Research Grant.*

### **Inferior Nasal Turbinate Morphology in Arctic and sub-Saharan African Humans: Implications for Understanding Climatic Adaptation in the Nasal Complex**

TARAH N. MARKS<sup>1</sup>, LAUREN N. BUTARIC<sup>2</sup>, SCOTT D. MADDUX<sup>3</sup> and ROBERT G. FRANCISCUS<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Iowa,

<sup>2</sup>Department of Anatomy, Des Moines University,

<sup>3</sup>Center for Anatomical Sciences, University of North Texas Health Science Center

Respiratory air conditioning is an important aspect of climatic adaptation in humans, and is governed predominantly by the amount of contact between respired air and mucosa within the internal nasal fossa. Because the nasal turbinates directly influence the size, shape, and surface area of the mucosa-lined nasal passages, variation in turbinate morphology may substantially impact heat and moisture exchange within the nasal fossa. However, unlike the encapsulating walls of the nasal cavity, ecogeographic variation in nasal turbinate morphology has not been established. Accordingly, this study investigated variation in inferior nasal turbinate morphology employing linear measurements of inferior turbinate length, height, and breadth, as well as nasal passage and common meatus widths. These measurements were collected from CT-scans of crania from two climatically distinct, mixed-sex, modern human samples: Arctic (n=35) and sub-Saharan Africans (n=29). Permutation t-tests revealed the existence of significant ecogeographic differences in inferior turbinate morphology, with the Arctic sample characterized by significantly longer ( $p < 0.0001$ ), taller ( $p = 0.0005$ ), and wider ( $p = 0.011$ ) inferior turbinates compared to sub-Saharan Africans. Further, although the Arctic sample was found to possess slightly narrower nasal passages ( $p = 0.015$ ), greater breadth of the inferior turbinate resulted in substantially narrower common meatus dimensions ( $p < 0.0001$ ). Indeed, ANCOVA results show that Arctic individuals would possess significantly narrower common meatuses ( $p = 0.0002$ ) given the same nasal passage breadths as sub-Saharan Africans. These results suggest that turbinate morphology likely augments other, previously documented, aspects of nasal fossa anatomy which modulate heat and moisture exchange by increasing or decreasing contact between respired air and nasal mucosa.

### **Using Stable Isotopes to Assess Dietary Variation in Late Middle Woodland Settlements in the Central United States: Evidence from Human Burials at Monkey Mountain (23J014) Warrensburg, Missouri**

HANNAH E. MARSH<sup>1</sup>, ANNA J. WATERMAN<sup>2</sup> and ROBERT H. TYKOT<sup>3</sup>

<sup>1</sup>Department of HAASS, University of Central

Missouri, <sup>2</sup>Department of Biology, Mount Mercy

University, <sup>3</sup>Department of Anthropology, University of South Florida

Monkey Mountain (23J014) is a Late Middle Woodland burial mound site outside of Warrensburg, Missouri at which the fragmentary remains of seven individuals were discovered inside a stone crypt. Skeletal samples were taken from the recovered individuals and stable isotopic analyses ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$  and  $\delta^{18}\text{O}$ ) were completed on bone apatite and collagen at the Bone Chemistry Laboratory at the University of South Florida.  $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$  and  $\delta^{18}\text{O}$  values from bone collagen and apatite provide information about protein type and intake,  $\text{C}_4$  plant intake, water sources and breastmilk consumption. The results of this study show that in this burial group diets were based on terrestrial proteins and  $\text{C}_3$  plants. The  $\delta^{13}\text{C}$  apatite values suggest that some variability in carbohydrate and/or dietary fat sources existed between individuals but little or no evidence of the adoption of maize agriculture is found. Both of the infants exhibited elevated  $\delta^{15}\text{N}$  providing evidence of breastmilk consumption. Two of the adults exhibited  $\delta^{15}\text{N}$  values greater than 10 ‰. This may indicate high protein consumption or the consumption of fresh water fish or woodland omnivores. As evidenced by this, and other contemporaneous studies, prior to the largescale adoption of maize agriculture, human diet in the Late Middle Woodland was still fairly heterogeneous, even within small settlement groups.

### **Identifying the Ecological Mechanisms Promoting Long-term Co-existence in a Mega-diverse Assemblage of Vertebrate Frugivores at Gunung Palung National Park, West Kalimantan, Indonesia**

ANDREW J. MARSHALL<sup>1</sup>, LYDIA BEAUDROT<sup>2</sup> and HEIKO U. WITTMER<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Michigan,

<sup>2</sup>Department of Ecology and Evolutionary Biology,

University of Michigan, <sup>3</sup>School of Biological Sciences, Victoria University of Wellington

Identifying mechanisms that permit co-existence of species in diverse tropical communities is of great theoretical interest and holds substantial practical relevance for conservation. This information has nevertheless proved elusive, in large part because it is usually unfeasible to gather sufficiently detailed data on all potential competitors across the broad spatial and temporal scales necessary to detect relevant ecological interactions. We systematically assessed diet composition, habitat occupancy, and relative abundances of vertebrate frugivores in 24 families (comprising five mammalian and seven avian Orders) for eight years in seven forest types at Gunung Palung National Park, West Kalimantan, Indonesia. Concurrent phenological monitoring permitted examination of the effects of spatial and temporal variation in habitat productivity on patterns of space and resource use. We

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quantified niche overlap and tested hypotheses about the ecological mechanisms that might mitigate the potential for competition, including habitat switching, spatial partitioning, and utilization of distinct foods during periods of fruit scarcity. Overlap in use of both space and fruit resources was high, especially among hornbills, primates, and squirrels. Using GLMMs and model selection, we found little evidence of spatial partitioning or habitat switching, but clear evidence that the diets of vertebrate frugivores diverged significantly during periods of low fruit availability. These results identify the ecological mechanisms that currently structure this community, and inform general hypotheses about how mega-diverse communities evolve and persist.

We thank the Leakey Foundation, Orangutan Conservancy, Hellman Foundation, Mohamed bin Zayed Foundation, Seneca Park Zoo, Ape TAG Conservation Initiative, UC Davis, Victoria University of Wellington, and University of Michigan.

### Relationship of Turbinal Surface Area and Nasal Cavity Volume in Primates

MOLLY C. MARTELL<sup>1</sup>, TIMOTHY D. SMITH<sup>2</sup> and VALERIE B. DELEON<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>School of Physical Therapy, Slippery Rock University

This study investigates the relationship of turbinal surface area (TSA) and nasal cavity volume (NCV) in select primates. Previously we showed phylogenetic differences in development of nasal turbinals based on qualitative observations. Here, metric data provide objective support for these conclusions. Crania of lemurs (*Lemur catta*), bushbabies (*Otolemur crassicaudatus*), and callitrichines (*Cebuella pygmaea*; *Saguinus oedipus*) at birth and as adults were analyzed using CT image data. The perimeter of the turbinals (as a 2D proxy for TSA) and the area of the nasal cavity (as a 2D proxy for NCV) were measured from coronal slices at the 1<sup>st</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 99<sup>th</sup> percentiles of nasal cavity length for each specimen. We hypothesized that the greater number of turbinals in strepsirrhines compared to haplorhines would be associated with a relatively greater ratio of TSA to NCV. However, results indicated a complete overlap of strepsirrhines and haplorhines, with *Otolemur* showing the greatest relative TSA, *Lemur* showing the lowest relative TSA, and the haplorhines falling in between. There is a significant linear correlation of TSA and NCV in the adult primates. The pattern of relative TSA observed among the adult primates is largely apparent in the neonate specimens, with *Otolemur* showing the highest relative TSA values in both adults and at birth. Previously, we described precocial ossification of turbinals in *Otolemur*, and delayed ossification of turbinals in *Lemur catta*. These findings are substantiated by the relative TSA values observed here.

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### A Complex, Polygenic Architecture for Lightened Skin Pigmentation in the Southern African KhoeSan

ALICIA R. MARTIN<sup>1,2,3</sup>, CHRISTOPHER R. GIGNOUX<sup>1</sup>, MENG LIN<sup>4</sup>, JULIE M. GRANKA<sup>5</sup>, ALEXANDRA ADAMS<sup>1</sup>, XIAOMIN LIU<sup>6</sup>, ELIZABETH G. ATKINSON<sup>4</sup>, CATHERINE A. GUENTHER<sup>7</sup>, SANDRA BELEZA<sup>8</sup>, CEDRIC J. WERELY<sup>9</sup>, JUSTIN MYRICK<sup>4</sup>, MARLO MÖLLER<sup>2</sup>, DAVID M. KINGSLEY<sup>7</sup>, MARK J. DALY<sup>2,3</sup>, MARCUS W. FELDMAN<sup>5</sup>, EILEEN G. HOAL<sup>9</sup>, CARLOS D. BUSTAMANTE<sup>1</sup> and BRENNAN M. HENN<sup>4</sup>

<sup>1</sup>Department of Genetics, Stanford University, Stanford, CA, <sup>2</sup>Analytic & Translational Genetics Unit, Massachusetts General Hospital, Boston, MA, <sup>3</sup>Program in Medical and Population Genetics, Broad Institute, Cambridge MA, <sup>4</sup>Department of Ecology and Evolution, SUNY Stony Brook, Stony Brook, NY, <sup>5</sup>Department of Biological Sciences, Stanford University, Stanford, CA, <sup>6</sup>Beijing Genome Institute, Shenzhen, China, <sup>7</sup>Department of Developmental Biology, Stanford University, Stanford, CA, <sup>8</sup>Department of Genetics, College of Medicine, Biological Sciences and Psychology, University of Leicester, UK, <sup>9</sup>Division of Molecular Biology and Human Genetics, Stellenbosch University, Tygerberg, South Africa

While >200 genes have been associated with pigmentation in animal models, fewer than 15 have been directly associated with skin pigmentation in humans. This has led to its characterization as a relatively simple quantitative trait. We show that skin color is more variable in admixed and equatorial populations by comparing phenotypes from ~5000 individuals in >30 populations, providing evidence of increased polygenicity closer to the equator. Strikingly, no quantitative gene discovery efforts for pigmentation have yet been published in continental Africa, despite skin pigmentation varying more there than any other continent. Light skin pigmentation is observed in the southern latitudes of Africa among KhoeSan hunter-gatherers of the Kalahari Desert. The KhoeSan are unique in their early divergence from other populations, dating back at least ~100,000 years. We demonstrate that skin pigmentation is highly heritable ( $h^2 > 0.85$ ), with similar estimates from pedigrees identified via ethnographic interviews, unrelated population-based samples, and haplotype sharing. Further, genes previously associated with skin pigmentation, rapidly evolving genes, and pigmentation genes discovered in animal models explain significantly more heritability than random genes. We show that some canonical pigmentation loci, including SLC24A5, are polymorphic in the KhoeSan and at higher frequency than explained by recent European admixture alone. We identify novel skin pigmentation loci, including near SMARCA2 and TYRP1, using a genome-wide association approach complemented by targeted resequencing in >440 individuals. Our results suggest that pigmentation

loci can evolve rapidly in response to latitude and highlight the utility of studying geographically and genetically diverged populations for understanding human adaptation.

### “Skeletal Maturation” vs. “Critical Fat Threshold” in relation to Pubertal Development in Qom Girls

MELANIE A. MARTIN and CLAUDIA VALEGGIA  
Anthropology, Yale University

Both pelvic dimensions and fat stores appear uniquely selected for in human females relative to other primates. Similarly, both skeletal growth and adiposity exhibit rapid growth during adolescence mediated by energy availability, and both have been proposed to mediate variation in the onset and progression of pubertal development—i.e., the “skeletal maturation” vs. “critical fat threshold” hypotheses. We argue that cephalopelvic constraints in human females and greater sensitivity of body fat to short term fluctuations in energetic conditions would have favored reproductive maturation more strongly attuned to structural status than fat accumulation. As a test of the two competing hypotheses, we evaluate age at menarche in association with changes in linear growth, weight, and BMI among the Qom, a well-nourished indigenous population in the Gran Chaco region of Argentina.

Anthropometric measures and menarcheal status were collected monthly from 61 periurban Qom girls aged 7-14 from 2011-2015 ( $n = 1441$  observations). Median age at menarche estimated by Kaplan-Meier survival analysis was 11.6 years (138.9 months, 95% CI = 136.4-142.8). We generated separate SITAR growth curve models to examine differences in trajectories of height, weight, and BMI velocity. We then use a joint modeling approach to compare the relative influence of changes in height, weight, and BMI on time to menarche. We demonstrate how associations between age at menarche and height vs. BMI can vary based on static or dynamic modeling, and discuss implications for anthropological and epidemiological studies of variation in pubertal development.

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### Evolution of brain size in *Macaca fascicularis* on Southeast Asian islands

ROBERT D. MARTIN<sup>1</sup> and LU YAO<sup>2</sup>

<sup>1</sup>Integrative Research Center, The Field Museum of Natural History, <sup>2</sup>Mammalogy/Sackler Institute, American Museum of Natural History

According to the Island Rule, large-bodied animals tend to evolve toward smaller body size and small-bodied animals toward larger body size on islands, mostly due to ecological release and limited resources. However, this rule originally applied to body size alone, and it is

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unclear whether it applies to individual anatomical features, such as the brain. Here, we analyze brain size in *Macaca fascicularis* from islands and the mainland in Southeast Asia using both raw and phylogenetically corrected data. Regression analysis of endocranial volume relative to body size reveals no difference between island-living mammals and mainland relatives, but females have statistically significantly larger relative brain sizes than males. When relative brain size is analyzed against island size, both female macaques in general and macaques of both sexes living on smaller islands have significantly but only slightly smaller relative brain sizes, with slopes very close to zero. Because only specific groups of long-tailed macaques appear to have marginally smaller relative brain size on islands, and given that this slight reduction may be driven by the small sample sizes available for specimens on very small islands, our results provide no support for the interpretation that the Island Rule applies to brains.

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### Energetics of the Nasal cavity: The impact of Total Energy Expenditure on Cranial Airway Morphology

VERONICA N. MASON<sup>2</sup>, ROBERT S. SCOTT<sup>1,2</sup> and SUSAN CACHEL<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, Rutgers University,

<sup>2</sup>Center for Human Evolutionary Studies, Rutgers University

As a skeletal component of the respiratory system, the nasal cavity places a finite limit on the maximum volume of air possible with each inhalation. This volume in turn limits the amount of oxygen available for meeting metabolic demands, including those generated by basal metabolic rate and by activity levels. This suggests that metabolic and behavioral traits may place a selective pressure on nasal cavity morphology. To assess this relationship in primates, we compare measurements of the nasal cavities with estimates of Total Energy Expenditure (TEE) for a broad sample of extant primate taxa. Nasal cavity dimensions were measured for 268 individuals across 29 primate species with TEE estimates available in the literature. Measurements addressed the anterior (piriform aperture) and posterior (choanae) ends of the nasal cavity, the nasopharynx, and total nasal cavity length. Interspecific analysis suggests that while most skull metrics display negative allometry when scaled to TEE and body mass, key nasal variables, particularly those describing the piriform aperture, scale isometrically. These results suggest a selective or ontogenetic pressure for the nasal cavities to remain large, counteracting pressures which limit the size of other cranial features. Our results indicate that energetic variables may play a role in shaping nasal morphology, potentially yielding insight into the energetics and nasal adaptations of both modern and fossil primate taxa.

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### Market Integration and Lifestyle in Vanuatu, and their Effects on Health

ERIC D. MASSENGILL and SIOBHAN M. MATTISON  
Anthropology, University of New Mexico

The Melanesian nation of Vanuatu is currently undergoing rapid but uneven market integration. Access to education, market goods, and international media varies from island to island, and from village to village. Market integration is also happening under geographically varying legal customs of land rights and conflict resolution. This patchwork of economic development and culture among otherwise closely related peoples allows us to examine the behavioral and biological correlates of market integration under the conditions of a 'natural experiment'. In this poster, we describe the lifestyle differences among individuals residing in the highly developed capital city of Port Vila and several different communities on the relatively undeveloped island of Tanna. We then explore how these differences map onto anthropometric markers of health across the lifespan. Preliminary results suggest that market access and market participation are associated with increased hypertension, waist circumference, and BMI. Given the rapid pace of development in Vanuatu and elsewhere in Austronesia, these results provide important information on how regional development affects health indicators though market access and subsistence activities.

*This research was conducted with funding from the National Science Foundation and the University of New Mexico.*

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### Population-level Ontogenetic Variation in Gorilla and Pan

JASON S. MASSEY and KIERAN P. MCNULTY  
Anthropology, University of Minnesota

African ape biology provides an important comparative framework for interpreting human evolution. When collecting data in museums, researchers group specimens from multiple localities, subspecies, and even species. While this allows for larger sample sizes, it averages genetically and morphologically distinct samples. In fact, it is known that morphological differences exist among populations of chimpanzee and gorilla adults. Likewise, adult differences among human populations have been attributed to differing ontogenetic trajectories, but population-level (i.e., infraspecific groupings) ontogenetic trajectories in extant African apes have yet to be studied. Thus, the current framework of ape ontogeny from which we interpret the human fossil record is based on unrealistic

and statistically untested biological models. This study is one part in a broader project which seeks to address infraspecific ontogenetic variation in *Gorilla* and *Pan*.

We used landmark-based Procrustes analysis on *Gorilla* and *Pan* crania to assess patterns of ontogeny at multiple taxonomic levels. Ontogenetic trajectories were studied by regressing superimposed shape variables on log(centroid size). Differences between populations were computed as the multivariate angle between trajectories and tested for significance using permutation tests.

We show that the observed infraspecific differences in African ape adults are due to differing ontogenetic trajectories. The results of this research show characterizing fossils as growing as either chimp-like or human-like does not fully grasp the biological complexity of ontogeny. This research has broad implications for studies of human evolution by characterizing variation with increased biological validity in order to more accurately study heterochrony within our lineage.

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### The Biological Embodiment of Public Health Values: A Case Study from Two Working Class English Populations

SARAH A. MATHENA-ALLEN

Anthropology Department, University of Massachusetts Amherst

The rise in public health initiatives, and the increase in health and hygiene legislation, is also contemporaneous with other significant moments in European history including: the intensification of economic industrialization, increase in scientific values, and the expansion of the sanitation movement. Within the United Kingdom, this period is characterized by the contradictory discourses between conservatives and social reformers, specifically regarding the responsibility of the state to care for their populations and considerable social anxiety regarding the management of working class bodies. Yet most of the historical research in this period has only addressed these dynamics from a historical or biomedical perspective; consequently, integration between these discourses and the direct biological outcomes on working class populations have been understudied. Therefore, this poster addresses, from a bioarchaeological perspective, how the 'politics' of public health initiatives, due to changing politico-economic and social values, became embodied within working-class populations through increased overall health. More specifically, can the rise of moralistic and welfare reform discourses and the development of public health initiatives reflect direct improvements in the overall health of their populations, as evidenced within the skeletal record. This poster seeks to address this question with two post-medieval skeletal sub samples, Coronation Street

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(N=60) and Coach Lane (N=15). Preliminary results of subsamples from these collections show high frequencies of skeletal stress indicators, including oral insults, disease, and trauma. These results suggest working class populations experienced high allostatic loads and overall poor health in direct contradiction to increased public health initiatives.

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### Palatal Destructive Lesions in the St. Jørgen's Medieval Leprosarium: Paleopathological Analysis and Paleoepidemiological Inferences

VITOR MJ. MATOS and CARINA MARQUES

Research Centre for Anthropology and Health, Dep. of Life Sciences, University of Coimbra

This study aims at presenting new palaeopathological evidence regarding the prevalence of palatal perforation in leprosy and to discuss the relevance of this skeletal lesion to a better understanding of the epidemiology of leprosy in Denmark during the late medieval period. The skeletal material analysed consisted of 191 individuals from the St. Jørgen's medieval leprosarium cemetery, located in the city of Odense, and currently housed at the University of Southern Denmark (ADBOU). Skeletons belonging to 148 adults, from both sexes, and 43 non-adults were macroscopically observed and the destructive lesions affecting the hard palate were registered according to standard palaeopathological methods. Palatal perforation was found in 12.6% (24/191) of the skeletons. No statistical differences were found between sexes (males: 8.0% [n=6]; females: 14.3% [n=9]) or age groups (adults: 11.5% [n=17]; non-adults: 16.3% [n=7]). According to clinical literature, leprosy bone changes are uncommon in non-adult individuals and palatal perforations are even rarer. Thus, the unusually high frequency of palatal perforation found, specially in non-adults, raises interesting issues concerning the epidemiological profile of leprosy in medieval Denmark.

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### Tarsier Phylogenetic Inference using Museum Skin Samples

LAURA C. MATTHEWS

Anthropology, New York University, Genetics, New York Consortium in Evolutionary Primatology

Tarsiers are a unique lineage of primates that have the potential to inform investigations on early primate evolution as the sister group to anthropoids. We have a clear understanding of the phylogenetic placement of tarsiers relative

to other major primate groups, we have little understanding of the genetic diversity or species level relationships amongst extant tarsier species which include three genera: *Carlito*, *Cephalopachus*, and *Tarsius*. While tarsiers are sometimes included in primate-wide phylogenies, these studies generally only include a handful of samples and only tarsier mitochondrial loci.

High-quality genetic samples of tarsiers are hard to obtain, and it is even more difficult to obtain high-quality samples across the full tarsier range that extends from the Philippines, Borneo, Sulawesi, and to the southern tip of Sumatra. Museum samples provide a great alternative to recently collected blood or tissue samples. Museum samples have already been collected across the breadth of the tarsier range and they do not disrupt living tarsier populations, many of which are vulnerable or worse according to the IUCN Red List.

I attempted DNA extraction and sequencing on 28 museum skin samples from the American Museum of Natural History, the Field Museum of Natural History, and the National Museum of Natural History. DNA extracts ranged from 0.159-4.56 ng/ $\mu$ L of DNA. I sequenced thousands of nuclear loci from each sample using hyRAD sequencing and inferred the first multilocus nuclear phylogeny including all three tarsier clades. My results recovered a *Tarsius* (*Carlito* + *Cephalopachus*) relationship as found in previous phylogenetic investigations.

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### A reinterpretation of the Regourdou 1 burial using 3D photogrammetry and field notes from the original excavators

BRUNO A. M. MAURELLE<sup>1</sup>, TRENTON HOLLIDAY<sup>2</sup>, AURÉLIEN ROYER<sup>1</sup>, MAXIME PELLETIER<sup>7</sup>, STÉPHANE MADELAINE<sup>1,5</sup>, FRANÇOIS LACRAMPE-CUYAUBÈRE<sup>3,4</sup>, XAVIER MUTH<sup>4</sup>, CHRISTINE COUTURE-VESCHAMBRE<sup>1</sup>, ERWAN LE GUEUT<sup>3</sup>, EMMANUEL DISCAMPS<sup>6</sup>, ALAIN TURQ<sup>1,5</sup>, JEAN-PIERRE TEXIER<sup>1</sup> and CHRISTELLE LAHAYE<sup>6</sup>

<sup>1</sup>UMR5199 PACEA, CNRS, <sup>2</sup>Dpt of Anthropology, Tulane University, <sup>3</sup>Archéosphère, Bordeaux, <sup>4</sup>Get In Situ, Suisse, <sup>5</sup>Musée national de Préhistoire, Les Eyzies, <sup>6</sup>UMR5060 IRAMAT-CRP2A, Université Bordeaux Montaigne, <sup>7</sup>UMR7269 LAMPEA, Université d'Aix-en-Provence, <sup>8</sup>UMR5608 TRACES, CNRS, <sup>9</sup>Université de Rennes II

The site of Regourdou is situated in the community of Montignac-sur-Vézère (Dordogne, SW France), on the left bank of the Vézère Valley, at the top of the hill upon which the Paleolithic sites of Lascaux Cave and La Balutie are located. A partial Neandertal skeleton (Regourdou 1) was first discovered there in September 1957 under destructive and unscientific conditions. A salvage operation to remove the skeleton was led by François Bordes in October 1957. This was followed by more systematic excavations under the direction of Eugène Bonifay from 1961

to 1964. Bonifay interpreted Regourdou 1 as an intentional burial under a kind of tumulus, with the body lying on its left side in the fetal position. However, this hypothesis has never been reevaluated. We do so by considering new data: 3D photogrammetry of the site, Bordes' 1957 field notes, 2 unpublished 1957 drawings of the concentration of the human remains realized during the salvage operation, photographs from 1957 and 1961, new human remains, labels/text or text written on the bones, and the distribution of the 1961 spatially recorded objects. We argue that the 1957 human remains were in square G2 of Bonifay's 61-64 excavation grid, while the lower limb extremities were in square G3. Following the anatomical logic of the human body, we assume that Regourdou 1 was lying flat and elongated, perhaps on his left side, with his head to the west near the wall of the cavity. This hypothesis is then different from that previously proposed.

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### Generalised Procrustes Analysis on an ontogenetic series clarifies the two-bandage cranial modification technique in Migration Period Hungary

PETER R. MAYALL and VARSHA PILBROW

Anatomy and Neuroscience, University of Melbourne

The arrival of the Huns into Europe in the fourth century intensified the practice of intentional cranial modification. It has been postulated that the Huns used a two-bandage cranial binding technique to differentiate themselves from surrounding nomadic groups practising cranial modification. This study examines this hypothesis by using Generalised Procrustes Analysis to study cranial shape changes from childhood through adulthood in modified crania from Hungary, the centre of Hunnic power in Europe.

Twelve surface landmarks and two hundred and forty-one semi-landmarks were used to study ontogenetic trajectories in nine sub-adult and fifteen adult modified skulls from five Hungarian sites. A linear regression of Procrustes distance on log centroid size shows a highly significant ( $p < 0.05$ ) 58% correlation. The first and second principal components account for 49% of variance and provide significant separation of the juvenile, sub-adult and adult groups. Warping along the first two axes reveals the trajectory from marked flattening of the frontal and occipital regions with considerable expansion of the occipito-parietal region in juveniles to slightly diminished flattening in the same regions in adult modified crania, marking the first binding. Another depression extending from the post-bregmatic region inferiorly over the temporal region, marking the second binding is similarly projected from childhood to adulthood. These depressions,

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although still present, are slightly diminished in the adult crania.

The findings from this study indicate that the Huns advanced intentional cranial modification as a permanent, highly visible and uniform marker of social identity in populations under their control.

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### Confounding factors: are molecular methods of age estimation less vulnerable?

FELIX MAYER, TANJA ARENT, CHRISTINA BOES, ALEXANDRA RECKERT and STEFANIE RITZ-TIMME  
Institute for Legal Medicine, University Hospital Düsseldorf

Age estimation depends on many accounts on reliable reference data. Especially in a forensic setting, the influence of confounding factors is of high relevance. Since molecular methods will play an increasingly important role in the future, we performed a literature review focussed on the question, in how far these methods are affected by confounding factors.

Though different molecular approaches have been tested (e.g. telomere shortening, accumulation of deletions of mitochondrial DNA) to date only the racemization of aspartic acid has been established as a method of age estimation. This is due to the fact that the racemization rate is comparably unaffected by confounding factors with only extreme ambient temperatures having a measurable effect. A new but very promising method for age estimation in the future is the assessment of DNA methylation. There are already numerous publications that give an idea of how this method might be affected by confounding factors. An impact on the methylation-level has been demonstrated for environmental factors like air pollution and nutrition, as well as for intrinsic factors like diseases. There also seem to be differences depending on sex and ethnic background, however, these findings might also be caused by lifestyle and environment.

Our results demonstrate that molecular age estimation is affected by several influences, nevertheless, these methods are still very promising since they are also focus of clinical research, resulting in a very large database. Our future research will focus on the (forensic) anthropologic application of the assessment of DNA methylation, e.g. on skeletal tissue

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### Trauma, Stress, and Sociopolitical Change in the Lower Río Verde, Oaxaca, Mexico

ARION T. MAYES<sup>1</sup>, ARTHUR JOYCE<sup>2</sup> and SARAH BARBER<sup>3</sup>

<sup>1</sup>Anthropology, San Diego State University,

<sup>2</sup>Anthropology, University of Colorado, Boulder,

<sup>3</sup>Anthropology, University of Central Florida

Frequency and type of trauma as well as degenerative bony changes is presented for two sites located on the Pacific coast of Oaxaca, Mexico. Occupied from the Middle Formative to the Early Post-classic, Río Viejo is a 250 ha site on the west bank of the Río Verde. It was an urban center and the political seat of a regional polity. Cerro de la Cruz is a small Late Formative site covering 1.5 ha that is located in the floodplain. Suggestions that Cerro de la Cruz is an example of territorial expansion of Monte Alban, as well as the evidence against this, have been discussed elsewhere.

Cranial trauma provides the best evidence of interpersonal conflict, whereas accidental trauma generally is focused on the post-crania, and is associated with daily activities such as agriculture. The presence of cranial trauma at Río Viejo, 25% (n=3/12), and Cerro de la Cruz, 29% (n=7/24), and post-cranial trauma at Río Viejo, 21% (n=4/19), and Cerro de la Cruz, 4% (n=1/22), indicates that differences were not statistically significant. However, the type of trauma, with an emphasis of the lower leg and ankle at Río Viejo, is interesting regarding behavior and potential causal factors. Additionally, there was a statistically significant difference regarding osteophytosis [CC 25% (n=6/24), RV 90% (n=9/10)] and osteoarthritis [CC 29% (n=7/24), RV 82% (n=14/17)]. The centralization of Río Viejo, and its rise as the political center accompanied by the construction of monumental architecture and long-distance trade, may account for the observed variation.

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### Constructing Demographic Profiles in Commingled Collections: A Comparison of Methods for Estimating Age at Death in a Byzantine Monastic Assemblage

REBECCA C. MAYUS<sup>1</sup>, SUSAN GUISE SHERIDAN<sup>2</sup> and CLARK S. LARSEN<sup>1</sup>

<sup>1</sup>Department of Anthropology, The Ohio State University, <sup>2</sup>Department of Anthropology, University of Notre Dame

The commingling of human skeletal remains is a problem commonly faced by bioarchaeologists, especially those working with Near Eastern assemblages. The inability to reconstruct whole bones or skeletons leads to uncertainty in estimating age at death. We sought to address this issue by independently applying multiple aging methods to a commingled assemblage, under the hypothesis that certain methods would have a greater level of concordance than others and would thus more accurately represent age distributions. The Byzantine St. Stephen's assemblage, a large collection from a well-documented

Jerusalem monastic site (5th – 7th C CE), was used to test agreement between methods. Age at death was estimated using the Buckberry and Chamberlain (2002) and Lovejoy et al. (1985) methods for auricular surfaces and the Todd (1920) and Suchey-Brooks (1990) methods for pubic symphyses in adult skeletons. Subadult skeletons were aged by dentition (Ubelaker, 1989). Morphological data was supplemented by histomorphometric analysis of rib cross sections. Aging methods agree in that individuals from early childhood to old age are represented at the site. However, methodologies for the pubic symphysis suggest a fairly even distribution across adult age groups while those for the auricular surface show a greater prevalence of middle-aged and older individuals. This latter pattern may be more reliable given a greater auricular surface sample size, potential biases in preservation of older versus younger individuals, and/or differences in accuracies of the aging techniques. This research highlights the importance of implementing a multifaceted approach to age estimation in commingled assemblages.

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### Unwelcome Guests: Human-rodent Commensalism and its Implications for Zoonotic Disease Transfer

COLLIN M. MCCABE<sup>1,2</sup>, HILLARY S. YOUNG<sup>3</sup>, SARA B. WEINSTEIN<sup>3</sup> and CHARLES L. NUNN<sup>2</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University,

<sup>2</sup>Evolutionary Anthropology, Duke University,

<sup>3</sup>Ecology, Evolution, and Marine Biology, UC Santa Barbara

The advent of agriculture and sedentary human lifestyles likely increased patterns of contact between humans and rodents, with implications for zoonotic disease transmission. However, little is known about what drives rodents to commensal lifestyles and how these behaviors alter parasitism and subsequent spillover risk to humans. We tested the hypotheses that (1) commensality among rodents is associated with greater exploratory behavior, and (2) increased exploration is associated with greater parasitism in commensal species.

We studied 16 rodent species in central Kenya, where many local human populations have recently adopted sedentary agricultural practices. We live-trapped rodents in homes and in nearby wildlife reserves over 4 seasons in 16 different villages. We used open-field and hole-board tests to assess rodent exploratory behavior. To assess infection status, we combed fur for ectoparasites, counted eggs in fecal samples and collected all helminths from the gastrointestinal tract.

Analyses indicate a trend for commensal rodents to be more exploratory than non-commensal rodents [ $F_{1,26}=3.045$ ,  $p=0.093$ ], but counter to predictions, gastrointestinal parasite abundances were negatively correlated with exploration

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[ $r=-0.145$ ,  $p=0.042$ ]. Gastrointestinal parasite richness and ectoparasite abundances were both also lower in commensal rodents [ $F_{21,136}=5.401$ ,  $p<0.001$ ;  $F_{21,136}=6.043$ ,  $p<0.001$ ]. These results indicate that, perhaps due to lower host biodiversity and parasite-sharing, or even increased nutrition from stored foods in human homes than in the wild, commensals are less parasitized than non-commensals. However, although parasite diversity was lower in commensal rodents, many of these individuals hosted parasites, including known vectors of human pathogens in the region.

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### Methodological Comparison of the Macroscopic vs. Radiographic Assessment of Cranial Porosities within the Texas State University Donated Skeletal Collection

BRITTANY S. MCCLAIN and MICHELLE D. HAMILTON

Anthropology, Texas State University

The assessment of porotic hyperostosis (PH) and cribra orbitalia (CO) in crania can be difficult if porosities do not present as classical lesions. Therefore, this research tests the Stuart-Macadam (1987) radiological method of assessing orbital and ectocranial porosities suggestive of PH and CO versus visual macroscopic analysis alone.

Modern crania from the Texas State University Donated Skeletal Collection ( $n=50$ ) were examined macroscopically, and the presence/absence of orbital/ectocranial porosities was recorded and scored. For the radiographic analysis, radiographs were taken and scored for the presence/absence of traits as defined by Stuart-Macadam (1987). The purpose of the study is to comparatively evaluate which analytical method provides the most reliable assessment of porosities suggestive of PH/CO. It was assumed that radiographs would identify the presence of both macroscopically visible ectocranial porosities, as well as those not apparent macroscopically.

Macroscopic results indicate 78% (39/50) displayed ectocranial porosities, and 16% (8/50) exhibited orbital porosities. Radiographically, using Stuart-Macadam's criteria, 48% (24/50) displayed outer table thinning, 24% (12/50) diploic thickening, and 22% (11/50) orbital roof thickening. The differences between the macroscopic versus radiographic analyses indicate the challenges researchers face when utilizing only one approach to the assessment of cranial porosities potentially indicative of PH/CO.

The results of this methodological comparison may have utility in both bioarchaeological

and forensic contexts when orbital/ectocranial porosities suggestive of PH/CO are indicated or suspected.

### Proximal Humeral Evidence for Partitioning of Locomotor Substrates by four Catarrhine Species from the Middle Miocene of Maboko Island, Kenya

MONTE L. MCCROSSIN and BRENDA R. BENEFIT  
Anthropology, New Mexico State University

A unique perspective on cercopithecoid-hominoid differentiation is provided by proximal humeri of four catarrhine species from Maboko Island, Kenya: *Victoriapithecus macinnesi*, "*Micropithecus*" *leakeyorum*, *Mabokopithecus clarki* or *Nyanzapithecus pickfordi*, and *Kenyapithecus africanus*. These species reveal partitioning of locomotor substrates by sympatric monkeys and apes during the African middle Miocene.

Ancestral catarrhine conditions are seen in the slow arboreal quadrupedalism of *Aegyptopithecus*: posteriorly directed humeral head, greater tuberosity projecting proximally to the same level as the humeral head, relatively massive lesser tuberosity, and broad/shallow intertubercular sulcus. Proximal projection of the greater tuberosity above a flattened humeral head suggests acquisition of semi-terrestrial adaptations by the formative cercopithecoid *Victoriapithecus* (5-7 kg) and the large-bodied ape *Kenyapithecus* (28-32 kg). In contrast, significant proximal projection of a spheroidal humeral head above a relatively reduced greater tuberosity in the diminutive ape "*Micropithecus*" *leakeyorum* (3-5 kg) and the primitive oreopithecoid *Mabokopithecus* or *Nyanzapithecus* (8-10 kg) indicates that they had evolved enhanced shoulder mobility.

The emergence of more seasonal woodland environments during the middle Miocene resulted in the independent colonization of open-country terrestrial habitats by ancestral cercopithecoids and large-bodied African apes. Although none of the Miocene apes exhibits the medial orientation of the humeral head, strong reduction of the lesser tuberosity, and the narrow/deep intertubercular sulcus of modern species, small- and medium-sized hominoids from Maboko were engaging in more active arboreal climbing than was true of the common ancestor of Old World monkeys and apes, reflective of foraging patterns involving greater consumption of ripe fruits and mature leaves, respectively.

### Understanding the Degree of Craniometric Variation in South Texas Migrants

CHLOE P. MCDANELD<sup>1</sup>, TIMOTHY P. GOCHA<sup>1</sup>, COURTNEY C. SIEGERT<sup>1</sup>, RYAN M. STRAND<sup>1</sup>, LORI E. BAKER<sup>2</sup> and M. KATHERINE SPRADLEY<sup>1</sup>

<sup>1</sup>Anthropology, Texas State University, <sup>2</sup>Anthropology, Baylor University

The rise in migrant deaths at the South Texas border has created a humanitarian crisis that overwhelms local jurisdictions and presents unique challenges to identification. Often, migrants are thought to predominantly originate from Mexico; however, missing persons data from the South Texas Human Rights Center indicates that 40.5% of those missing are Mexican Nationals, while 41.7% come from Central America, mostly El Salvador, Honduras, and Guatemala. The purpose of this study is to learn more about the South Texas migrants by exploring craniometric variation to assess whether they represent a single, homogenous population group, or diverse mixture of population groups.

The sample consists of 70 crania, currently part of the Operation Identification (OpID) project at Texas State University. Individual Mahalanobis distances ( $D^2$ ) were calculated using DISPOP and 15 interlandmark distances that maximized sample size. The Defrise-Gussenhoven statistic was used to assess overall homogeneity of the sample with results indicating a homogenous sample. The migrants were also compared to population groups from the Forensic Anthropology Data Bank commonly used in forensic anthropology practice, American Black, White, and Hispanic, to assess variation among groups. The natural log of the determinant of the covariance matrices indicated that the OpID sample displayed the least amount of variation. These results suggest that the South Texas migrant sample are relatively homogenous and not representative of a geographically diverse mixture of groups. Understanding the biological variation present within migrants found in South Texas, and how it might reflect geographical origin, can ultimately help facilitate their identification.

### Meet me at the airstrip: Fission-fusion dynamics and ranging patterns in a kindachacma hybrid baboon group

MONICA M. McDONALD  
Anthropology, Washington University

Ranging patterns of baboons can vary greatly depending upon the environment in which they live and the size and social structure of the group. In most savanna baboon species, baboon groups range various distances as a *single* multi-male multi-female group. In contrast, both hamadryas and guinea baboons have a multi-level grouping structure with one-male units that combine into groups of varying sizes in various contexts.

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Here I present the first analysis of the ranging patterns and social structure of a 64-member group of *kinda*-chacma hybrid baboons in Kafue National Park, Zambia. From November 2012 to July 2013, I followed the group daily and recorded 106 days of GPS track logs. A minimum convex polygon (MCP) was used to calculate their home range size. Their total home range was 92 km<sup>2</sup>, the perimeter of their range was 39 km, and their home range use varied seasonally. In addition, between the months of May and July (2013-2016), this group was observed to occasionally "fuse" with another similarly sized group in the evenings and "fission" again in the mornings. While "subtrooping" has been observed in *chacmas*, the stable, but temporary, "fission-fusion" pattern observed in this group is rare; nothing is known about *kinda* baboon ranging patterns. Since this behavioral pattern correlates well with the dry season and the hunting season, this behavior is likely an environmental-specific response that serves to protect the group against predators (including humans) during seasons when the group must range greater distances for food and/or water.

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### Feverish Monkeys get Kicked when they're Down

RICHARD MCFARLAND<sup>1,2</sup>, LOUISE BARRETT<sup>2,3</sup>, ANDREA FULLER<sup>2</sup>, PETER HENZL<sup>3,4</sup>, SHANE K. MALONEY<sup>2,5</sup>, DUNCAN MITCHELL<sup>2</sup>, CHRISTOPHER YOUNG<sup>3,4</sup> and ROBYN S. HETEM<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Wisconsin-Madison, <sup>2</sup>School of Physiology, University of the Witwatersrand, <sup>3</sup>Department of Psychology, University of Lethbridge, <sup>4</sup>ABEERU, University of South Africa, <sup>5</sup>School of Anatomy, Physiology and Human Biology, University of Western Australia

Fevers are an adaptive response of the host when fighting infection. For gregarious animals, however, symptoms of a fever, such as increased lethargy, could signal to other group members that their competitive ability is compromised. Bystanders may act to capitalize on this apparent weakened status and assert dominance over febrile individuals. We implanted wild vervet monkeys (*Chlorocebus pygerythrus*) with data loggers to obtain continuous measures of core body temperature. These data were used to detect fevers and to examine the behavioral correlates of febrile episodes. We detected 63 fevers in 30 individuals over a five-year study period. Fevers were characterized by a persistent 0.5°C elevation in mean 24h body temperature. Fevers lasted between two and 14 days. Mean 24h body temperatures were significantly higher when animals were febrile (38.9±0.3°C) compared to afebrile (37.9±0.3°C) (t=18.6, df=29, P<0.001).

Animals reached a maximum body temperature of 40.6±0.5°C during fevers. Animals spent significantly more time resting (t=2.33, df=18, P=0.03) and significantly less time feeding during febrile compared to afebrile periods (t=3.5, df=18, P=0.003). Social and travel times were not significantly predicted by febrile period (both P>0.05). Male vervet monkeys appear to be able to detect when other males are sick, and take advantage of their reduced competitive ability by targeting them with physical aggression. Although fevers are considered an adaptive response to infection, our results suggest that the sickness behaviors associated with fevers, and their agonistic consequences, may negatively impact the wellbeing and fitness of febrile individuals.

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### Histological examination of molar development in Virunga mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda

SHANNON C. MCFARLIN<sup>1,2</sup>, DONALD J. REID<sup>1</sup>, KEELY ARBENZ-SMITH<sup>1</sup>, MICHAEL R. CRANFIELD<sup>3</sup>, TARA S. STOINSKI<sup>4</sup>, TIMOTHY G. BROMAGE<sup>5</sup> and ANTOINE MUDAKIKWA<sup>6</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University, <sup>2</sup>Division of Mammals, National Museum of Natural History, Smithsonian Institution, <sup>3</sup>Mountain Gorilla Veterinary Project, Baltimore Zoo, <sup>4</sup>Dian Fossey Gorilla Fund International, Zoo Atlanta, <sup>5</sup>Department of Biomaterials and Biomimetics, New York University College of Dentistry, <sup>6</sup>Department of Tourism and Conservation, Rwanda Development Board

Enamel and dentine microanatomy records information about the rate and duration of tooth development. While dental development data from great apes provide an important comparative reference for reconstructing developmental life history in the human fossil record, opportunities to examine individuals from well-documented wild populations are rare and some taxa are poorly known. We report on a histological examination of dental development in Virunga mountain gorillas from Volcanoes National Park, Rwanda (N=4F, 2M; 2.8-est. 8 years). In first and second mandibular molars (M1, M2), we used histological methods to determine cusp-specific formation times, daily secretion and extension rates, and other crown and root formation parameters. Periodicity was either 6 or 7 days across individuals (median=7). Prenatal initiation of M1 calcification occurred at a mean 0.19 years (range: 0.12-0.26, mb cusp) before birth, which is considerably earlier than published *Gorilla* specimens of wild and unknown provenance and more similar to published data for a single captive western gorilla. Duration of M1 buccal cusp formation was 2.37-2.49 years in females,

and 2.61 years in a single male. In one individual, M2 initiation at 2.11 years occurred 0.16 years before M1 crown completion. The first such data for eastern gorillas, our results expand the known range of variation and suggest that mountain gorillas initiate M1 mineralization earlier on average than other great apes. Future studies will aim to resolve the influence of sex, population origin and other factors on dental development variation within the genus *Gorilla*, and its relationship to variation in life history.

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### Three-dimensional analysis of the distal humerus in catarrhines with implications for Miocene locomotor diversity

FAYE MCGECHIE, SHARON KUO and CAROL V. WARD

Pathology and Anatomical Sciences, University of Missouri

The distal humerus is a key indicator of forelimb use in hominoid locomotion. Contours of the distal articular surfaces reflect the stereotypical pronated forearm posture of monkeys during palmigrade quadrupedality, and the more varied suspensory locomotor repertoire of apes. The pronounced lateral and medial trochlear margins and the zona conoidea have been described qualitatively in anthropoids and used to infer locomotor adaptation in fossil taxa, but have been difficult to quantify. Here we use a 3D approach to examine extant catarrhines to understand forelimb use in differing locomotor repertoires and apply these findings to Miocene hominoids.

Humeri from individuals representing nine extant (n=76) and eight fossil catarrhine genera were laser scanned. Data were collected on the resulting polygonal models in *Polyworks*. Circles were fitted to the medial and lateral trochlear keels, mid-trochlea, zona conoidea and capitulum. Ratios of the radii of curvature of the zona conoidea were then calculated to minimize size effects.

MANOVA demonstrates that monkeys and apes differ significantly in distal humeral articular morphology (p< 0.001). Discriminant function analysis separates apes and monkeys based on the mid-trochlear groove to lateral trochlear ridge ratio, indicating the utility of this proportion for reconstructing locomotor emphasis of fossil animals. *Afropithecus* and *Sivapithecus* fall within the range of extant apes while *Proconsul* shows intermediate morphology. This study provides a novel quantification of zona conoidea morphology using measurements that are easily applied to fossils. It bolsters the form-function relationship between humeral morphology and locomotor behavior and offers insights into Miocene locomotor diversity.

# ABSTRACTS

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## A Woman's World: Rate of Morphological Dilemmas in Romano-British Childbirth

CANDACE MCGOVERN

Department of Archaeology, University of Reading

Humans are prone to an obstructed labour or other difficulties during childbirth due to the evolutionary morphological changes required to accommodate bipedal movement and a larger brain size. This combination can make a vaginal birth extremely hazardous. Within archaeological populations the high frequencies of females is often attributed to an obstetric dilemma, particularly a contracted pelvis. This occurs when the pelvic inlet, mid-plane, or outlet is too small to allow for a viable neonate to pass through the birth canal. Without modern surgical intervention, this could lead to death for both the mother and neonate.

To establish the likelihood of a contracted pelvis the transverse and cognate measurements were collected from 100 Romano-British females with varying pelvis typologies between 10-45 years at death. The metric data was compared with pre-WW2 medical literature based on the size of a viable foetus and modern clinical measurements. Females below the pre-WW2 minimums were considered 'high risk' while those below the modern minimums labelled 'at risk'. Within the sample, 12% (n=12) had at least one pelvic inlet measurement in the 'high risk' category, while 42% (n=42) would be considered 'at risk'. The youngest individual who could possibly give birth vaginally was 14.08 years of age at death. Therefore, when compared to modern measurements Romano-British women were at risk of dying from a contracted pelvis; however, when compared to the smaller pre-WW2 measurements the rate drops significantly. This can provide a better understanding of the birthing process among archaeological populations and childbirth hazards.

## Quantifying linear enamel hypoplasia in Virunga mountain gorillas and other great apes

KATE MCGRATH<sup>1</sup>, SIREEN EL ZAATARI<sup>2</sup>, MIKE R. CRANFIELD<sup>3</sup>, TARA S. STOINSKI<sup>4</sup>, ANTOINE MUDAKIKWA<sup>5</sup>, TIMOTHY G. BROMAGE<sup>6</sup> and SHANNON C. MCFARLIN<sup>1,7</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, The George Washington University, <sup>2</sup>Paleoanthropology, Senckenberg Center for Human Evolution and Paleoenvironment, Universität Tübingen, <sup>3</sup>Mountain Gorilla Veterinary Project & Baltimore Zoo, <sup>4</sup>Dian Fossey Gorilla Fund International & Zoo Atlanta, <sup>5</sup>Department of Tourism and Conservation, Rwanda

Development Board, <sup>6</sup>Department of Biomaterials and Biomimetics, New York University College of Dentistry, <sup>7</sup>Division of Mammals, National Museum of Natural History, Smithsonian Institution

Linear enamel hypoplasia (LEH) is a condition marked by localized reductions in enamel thickness, usually in the form of horizontal bands around the tooth crown. These defects have been associated with stressors such as malnutrition and disease in clinical and experimental settings, yet their etiology in wild primates remains unclear. Previous studies have found LEH to be ubiquitous among great apes, with the exception of mountain gorillas. Two main hypotheses have been proposed to explain their low frequency: 1) mountain gorillas are buffered from seasonal lows in fruit availability as dedicated folivores, and/or 2) due to their rapid enamel growth, mountain gorilla defects are shallower than in other apes, and are therefore more difficult to detect. Here, 16 epoxy mandibular canine replicas from each of four great ape taxa (*Gorilla beringei beringei*, *G. gorilla gorilla*, *Pan troglodytes*, and *Pongo* sp.) were scanned using a Sensofar Plu Neox, and high-resolution digital elevation models (n=176) were analyzed using a new quantitative method. Defects were qualitatively targeted for scanning, and their presence was confirmed using the FindPeaks plugin in ImageJ software. Their depth ranged from 6-276 microns, with a mean of 42 microns, well outside the range of perikymata depth (>1-3 microns). As predicted, mountain gorillas exhibit significantly shallower defects than all other taxa (p<0.0001). Females have significantly deeper defects than males in all taxa (p=0.039). Next steps include evaluating the influence of underlying microanatomical differences on defect morphology, and incorporating available life history records to assess their etiology in wild mountain gorillas.

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## A 'Hypophysis' to Test: Comparative Aspects of Pituitary Gland Anatomy and its usefulness for Reconstructing Hominin Life History

AMANDA MCGROSKY<sup>1</sup>, JASON M. KAMILAR<sup>2</sup>, STACEY R. TECOT<sup>3</sup> and GARY T. SCHWARTZ<sup>1</sup>

<sup>1</sup>Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Anthropology and Graduate Program in Organismic & Evolutionary Biology, University of Massachusetts, Amherst, <sup>3</sup>School of Anthropology, University of Arizona

Pituitary hormones related to growth and reproduction play a central role in regulating mammalian life history. Recent work has

shown that pituitary gland (or hypophysis) size can predict growth rates in extant mammalian species, with larger anterior pituitary lobes linked to faster fetal and post-natal growth. Given the link between gland volume and growth rate, estimating pituitary size in extinct species would provide a novel way to infer growth in the past. The pituitary gland is seated within the hypophyseal fossa of the sphenoid bone, which is part of a larger bony structure termed the sella turcica. Because the bones of the sella turcica develop around the developing hypophysis, we predict that the volume of the hypophyseal fossa, as well as other sella turcica dimensions, will track pituitary gland volume such that primate species with larger glands will have greater bony dimensions. Additionally, we predict that growth rates increase as sella turcica volume increases.

We gathered anterior and posterior pituitary lobe, as well as total gland, volumes for 21 primate species from the literature. Data on sella turcica dimensions for representatives of the same species were measured from microCT reconstructions of crania available from Morphosource. Using PGLS, we show that the volume of the sella turcica increases as pituitary gland volume increases (R<sup>2</sup>=0.72, p<0.0001) as does one key measure of growth rate (R<sup>2</sup>=0.40, p<0.001). This represents a novel approach to reconstructing growth rates in the past and adds a new dimension to explorations of mammalian and primate life history evolution.

## The Importance of Shoes: Correlation between Grave Goods, Status, and Diet of Late Iron Age and Early Roman Individuals from Winterborne Kingston, UK

SARA A. MCGUIRE<sup>1</sup>, HOLGER SCHUTKOWSKI<sup>2</sup> and MARK HUBBE<sup>1</sup>

<sup>1</sup>Department of Anthropology, The Ohio State University, <sup>2</sup>School of Applied Sciences, Bournemouth University

The site of North Down Farm in Winterborne Kingston, UK, was intermittently occupied during the Late Iron Age to Early Roman periods. Analysis of the eighteen adults uncovered between 2009 and 2011 reveal distinct burial positions and grave goods which may indicate Roman influence and differences in status among the Winterborne Kingston adults. Here, we evaluate the stable isotope ( $\delta^{13}\text{C}_{\text{coll}}$  and  $\delta^{15}\text{N}_{\text{coll}}$ ) values from a subset of the burial population (N=18) to explore if the presence of grave goods and burial position are associated with distinct diet compositions, to test the impact these cultural variables had on some aspects of individuals' life-style.  $\delta^{13}\text{C}_{\text{coll}}$  values for all sampled individuals were consistent with a terrestrial C<sub>3</sub> diet (-21.66 ‰ to -20.06 ‰), and  $\delta^{15}\text{N}_{\text{coll}}$  values were consistent with terrestrial sources of dietary protein (7.79 ‰ to 9.95 ‰). There were no statistically significant differences among nitrogen values when individuals

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were compared by sex, status, or burial position. However, status was found to play a key role in explaining the variation in stable carbon isotope values ( $p = 0.047$ ). Additionally, the presence of hobnails, indicative of Roman footwear, was found to explain a significant amount of the variation in nitrogen isotope values ( $p = 0.003$ ). The presence of this association between burial characteristics and diet suggests that social status and affiliation with the Roman culture played a significant role in access to resources by local individuals, and offers insights into how social status was structured among British tribal populations.

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### Age, body size, and reproductive status affect $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values: Evidence from living Maya women from Guatemala

LUSEADRA J. MCKERRACHER<sup>1,2,3</sup>, MARK COLLARD<sup>2,4,5</sup>, PABLO NEPOMNASCHY<sup>2,6</sup> and MICHAEL P. RICHARDS<sup>4</sup>

<sup>1</sup>Faculty of Health Sciences, McMaster University, <sup>2</sup>Human Evolutionary Studies Program, Simon Fraser University, <sup>3</sup>Centre for Biocultural History, Aarhus University, <sup>4</sup>Archaeology, Simon Fraser University, <sup>5</sup>Archaeology, University of Aberdeen, <sup>6</sup>Faculty of Health Sciences, Simon Fraser University

Carbon and nitrogen stable isotope ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) measured in tissues recovered from archaeological contexts are often used to make inferences about past human diet. The existing evidence suggests that inter-individual variation in these values partly reflects variations in sources of dietary protein. More positive  $\delta^{13}\text{C}$  values are associated with diets in which a relatively large proportion of proteins derive from tropical grasses and/or animals that feed on such grasses, while higher  $\delta^{15}\text{N}$  values are associated with diets relatively rich in high trophic level (animal) proteins. However, the extent to which other, non-dietary factors may also influence  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  variation is currently poorly understood.

To assess the effects of non-dietary factors on  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  variation, we undertook a study of living people with known diets and metabolic states. The isotope data were obtained from fingernail samples from 65 indigenous, Guatemalan Maya women. Participants' recalled diets, ages, heights, weights, histories of weight gain/loss, activity loads and reproductive statuses were also measured and included in multivariate models of observed stable isotope values.

We found that age and height were the strongest predictors of variation in  $\delta^{13}\text{C}$ . Weight and breastfeeding status were the strongest predictors of variation in  $\delta^{15}\text{N}$ . Recalled diet did not significantly predict variation in  $\delta^{13}\text{C}$  or  $\delta^{15}\text{N}$ . These results suggest that age, height, weight, and

breastfeeding affect expression of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . This implies that body size and life history factors should be accounted for when using  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  to make inferences about past human diets.

### The Coloniality of Philosophies of Biology

SHAY AKIL MCLEAN

Sociology, University of Illinois at Urbana Champaign

Human biology is used as a technical tool to 'naturalize' contemporary socio-political orders. What is crucial to blood as well as bone and DNA in modernity is calculability. From Malthus to Darwin to Fisher, the calculability of demography was merged with the calculability of genetics to produce evolutionary theory. In this paper I critically assess (settler) colonial history of philosophies of biology to investigate the role of biology as a key ideological tool of coloniality (Quijano, 2000; Maldonado-Torres 2007). I argue that biology is central to enforcing colonial typologies that establish and justify relations of domination in part through defining and policing the boundaries of human populations. This is maintained through the colonial claim that "I am the species" (Sahlins 2008), which introduces a way in which the evolution of biological organisms then came to be understood as an evolution towards modern Eurowestern society. Demography, genetics, and evolution provide the means of calculation while the colonial claim of "I am the species" defines the space in which the calculus of life and death are implemented. Using the concepts of the calculus of life and I am the species, I demonstrate the role philosophies of biology play in maintaining relations of domination and with the aim of synthesizing an anti-colonial philosophy of biology. An anti-colonial philosophy of biology sets out to transform the means of calculability to then open the possibility for a radical human biology.

### You are how you eat: elucidating chewing patterns through 3D shape analysis of fossil primates

KIERAN P. MCNULTY<sup>1</sup>, RYAN P. KNIGGE<sup>1</sup> and CHRISTOPHER J. VINYARD<sup>2</sup>

<sup>1</sup>Anthropology, University of Minnesota, <sup>2</sup>Anatomy and Neurobiology, Northeast Ohio Medical University

The relationship between jaw form and masticatory function has been extensively researched in certain groups of living primates through experimental studies. This work has identified considerable variation in the activity of different masticatory muscles during feeding that likely reflect adaptive shifts in masticatory function. Nevertheless, such experiments are impossible with extinct organisms. This study aims at investigating the relationship between jaw-muscle activity patterns during chewing and jaw shape in extant primates to make inferences about fossil primate masticatory function. This was done by

correlating published electromyography (EMG) data from jaw muscles (i.e., relative muscle recruitment levels and firing patterns) with 3-D landmarks used to quantify mandibular shape. Initially, the whole mandible was digitized for species with functional data (N=9) to identify correlations between jaw shape and function. Secondly, a reduced number of landmarks and semilandmarks was used to accommodate fossils with missing data. Six fossil anthropoids and subfossil lemurs were plotted along the shape axes constructed using a partial least squares analysis to predict jaw-muscle EMG patterns. *Catopithecus* and *Parapithecus* fall within the anthropoid range and plot close to platyrrhines whereas *Epipliopithecus* and, unexpectedly, *Archaeolemur* plot nearer to catarrhines. *Megaladapis* and *Mesopropithecus* are similar to *Propithecus* and distinct from other strepsirrhines. These results suggest *Catopithecus* and *Parapithecus* potentially shared more derived patterns of masticatory function with platyrrhines (and crown anthropoids) rather than those exhibited by most strepsirrhines. Furthermore, the analysis identifies possible instances of functional convergence in physiological patterns during chewing (i.e., *Archaeolemur*) that were not previously hypothesized.

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### Re-examining the Peroneal Trochlea of the StW 352 Calcaneus

ELLISON J. MCNUTT<sup>1,2</sup>, ALEXANDER G. CLAXTON<sup>3</sup> and KRISTIAN J. CARLSON<sup>4,5,6</sup>

<sup>1</sup>Ecology, Evolution, Ecosystems, and Society, Dartmouth College, <sup>2</sup>Anthropology, Dartmouth College, <sup>3</sup>Anthropology, Boston University, <sup>4</sup>Cell and Neurobiology, Keck School of Medicine of University of Southern California, <sup>5</sup>Evolutionary Studies Institute and School of Geosciences, University of the Witwatersrand, <sup>6</sup>Anthropology, Indiana University

StW 352 is a partial calcaneus from Sterkfontein Member 4, South Africa, dated to ~2.0-2.6 Ma. The unusual robusticity of the peroneal trochlea (PT) of StW 352 has been commented on by several authors. The size of hominin PTs have been hypothesized to correspond to the degree of recruitment of peroneal longus to aid in bipedal locomotion and/or climbing. We present here two previously unrecognized structural issues that affect current interpretations of the functional morphology of StW 352. Visual examination of the calcaneus suggested that: 1) matrix infill has expanded and split the PT, and 2) during physical reconstruction, the PT was reattached incorrectly. Given the potential functional relevance of an enlarged PT, we investigated these possibilities using high resolution computed tomography (CT). Comparisons to calcanei from *Pan troglodytes* and *Homo sapiens*,

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and careful assessment of CT images of StW 352, both corroborate the visual interpretations. Based on the present investigation, the PT has been reattached to the body of the calcaneus ~5 mm dorso-distally from its correct anatomical position. Additionally, the presence of intrusive matrix has artificially expanded the PT laterally and proximodistally. Future studies examining this specimen with geometric morphometrics, or other shape analysis tools, should compensate for its inaccurate reconstruction before comparing it to other calcanei. Additionally, given that the PT is likely smaller than previously reported, caution should be exercised when using it to infer muscle function and to extrapolate activity patterns of this individual, and thus by extension, within, *Australopithecus africanus* in general.

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### Modeling Hominin Dispersal Patterns using Cost Path Analysis and Spectral Signature Models

RACHEL MCPHERSON and CHARLES M. MUSIBA  
Anthropology, University of Colorado Denver

Paleoanthropologists focus largely on known fossiliferous localities and fossils to answer questions about hominin behavior, yet certain behaviors, such as mobility patterns, remain poorly understood. The purpose of this research was to model *Australopithecus afarensis* dispersal between Laetoli, Tanzania and Kantis, Kenya through the use of Geographic Information Systems and Remote Sensing analyses. Two types of analyses were done; Cost Path Analysis (CPA) that creates the most energetically efficient route between two points based on landscape characterizations, and Spectral Signature Model (SSM) that uses spectral reflectances from satellite remote imagery to target likely locations of a given variable. Modern data were used because paleoenvironmental reconstructions in East Africa are inconsistent and nonspecific. Results were twofold: first, several paths were created that are predicted to be the routes *Au. afarensis* took between Laetoli and Kantis based on steepness of slope and location of waterbodies. Second, geological strata were targeted that are likely to contain evidence of this dispersal along those routes, such as fossils and tools. The model of *Au. afarensis* dispersal routes and targeted sediments was created from combining these two analyses into a map. This can be groundtruthed in the future to test the utility of model predicting *Au. afarensis* mobility patterns. These analyses do not require a focus on specific fossiliferous localities or fossils, and they have great potential for furthering our understanding of hominin dispersals as well as increasing our fossil base.

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### Trauma, Growth, and Death: An analysis of *Gorilla gorilla* life history from specimens at the Yale University Peabody Museum of Natural History

RYAN T. MCRAE and GARY P. ARONSEN  
Anthropology, Yale University

Museum zoological collections are of paramount importance for research into comparative anatomy, developmental biology, and life history markers for all extinct and extant species. This importance is compounded for threatened species, such as the Great Apes, as the data the collections provide are currently impossible to replicate. Evaluation of these skeletal collections provides insight into population, species, and individual level variation associated with environmental, social, and epidemiological history.

Here, we describe the *Gorilla gorilla* skeletal collection housed at the Yale Peabody Museum (YPM). A minimum of fourteen individuals are present, most consisting of predominantly cranial material. Multiple age and sex classes are represented. All skeletal elements were assessed regarding developmental, disease, trauma, and socioecological indicators. Multiple pathologies are present and are likely associated with nutritional and/or epidemiological factors. Instances of trauma due to both antemortem and perimortem events are described. Subspecific variation as well as variation between captive and wild individuals is also observable. The majority of the collection is documented as originating from West Africa.

This initial evaluation provides a foundation for further research on the gorilla material using alternate methods. These could include isotopic analysis of calculus for information on environment and diet as well as noninvasive genetic testing. Museum collections have continued to provide new insights into species variation, individual variation, and environmental cues, ultimately allowing for comparison between modern populations and their historic counterparts.

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### The Utility of Dental Cementum Increment Analysis for Estimating Season-of-Death in Naturally Decomposed Skeletons

LAUREN A. MECKEL and DANIEL J. WESCOTT  
Anthropology, Forensic Anthropology Center at Texas State University

Dental cementum increment analysis (DCIA) is the microscopic examination of the alternating mineralized layers in dental cementum. These layers can be seen as either a bright increment representing the growth season (spring/summer) or an opaque increment representing the dormant season (fall/winter). Wedel (2007) used DCIA to estimate the season-of-death with 99% accuracy in a sample of human teeth extracted from living individuals.

This study was designed to test and replicate the Wedel method using a modern skeletal sample of individuals (N=24) over the age of fifty, with known exact date-of-death, that have undergone natural decomposition processes. If the Wedel protocol is validated on a reference sample that decomposed in a natural environment, then this method will greatly improve the estimation of time-since-death in forensic and bioarchaeological contexts.

The results of two separate observations show that there is not a strong relationship between the optical nature of the outer band and the season-of-death as suggested by Wedel (2007). The accuracy of the method was 60 and 18 percent in the first and second observations, respectively. However, a known animal sample (n=13) and a single tooth from a 22 year old human were also tested and achieved an accuracy of 100%. Based on these results, DCIA is not recommended for use on individuals over fifty years of age and further research focusing on the effect of age on cementum growth is warranted.

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### The Social Worlds of Mothers, Infants, and Microbes: Cooperative Breeding and the Human Milk Microbiome

COURTNEY L. MEEHAN<sup>1</sup>, KIMBERLY A. LACKEY<sup>2</sup>, EDWARD H. HAGEN<sup>1</sup>, JANET E. WILLIAMS<sup>3</sup>, MARK A. MCGUIRE<sup>3</sup> and MICHELLE K. MCGUIRE<sup>2,4</sup>

<sup>1</sup>Department of Anthropology, Washington State University, <sup>2</sup>School of Biological Sciences, Washington State University, <sup>3</sup>Department of Animal and Veterinary Science, University of Idaho, <sup>4</sup>Paul G. Allen School for Global Animal Health, Washington State University

Although humans are cooperative breeders, detailed studies into the breadth of ways allomothers influence mothers and infants is still in its early stages. Here, we explore the relationships between a mother-infant dyad's (MID) allomothering networks and the human milk microbiome (HMM). We conducted three studies among hunter-gatherer and horticultural MIDs in the Central African Republic from 2009-2013. First, we examined the HMM of women (n=47) by amplifying and sequencing (to the genus level) the V1-V3 region of the bacterial 16S rRNA gene, hypothesizing that subsistence pattern would influence the bacterial composition of milk. Second, we documented children's (n=147) early care and social environments, predicting that caregiving is widely distributed across communities. Third, we conducted exploratory analyses on the relationship between MID's (n=34) caregiving and social networks and the HMM. We found few differences in the HMM between subsistence types, with *Streptococcus* (22.6%), *Staphylococcus* (17.3%), and *Veillonella* (4.9%) representing the

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most-abundant genera. Additionally, caregiving and social networks were remarkably dense, and intensive investment in children was not limited to key allomothers. Infants had contact with an average of 13 individuals daily. Lastly, we found a significant positive relationship between the MID's network and the diversity of the HMM, indicating that as the density of contact with others increased, so did the diversity of the mother's HMM. These studies represent the first available data on the HMM among small-scale societies and demonstrate that cultural and social variation may influence the composition of human milk.

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### Nectar and the genetic basis of ethanol metabolism in Euarachonta

AMANDA D. MELIN<sup>1,2</sup>, GWEN DUYSCHAEVER<sup>1</sup>, KONSTANS WELLS<sup>3</sup>, PERRY ONG<sup>4</sup> and NATHANIEL J. DOMINY<sup>5,6</sup>

<sup>1</sup>Anthropology and Archaeology, University of Calgary, <sup>2</sup>Medical Genetics, University of Calgary, <sup>3</sup>Environmental Futures Research Institute, Griffith University, <sup>4</sup>Institute of Biology, University of the Philippines Diliman, <sup>5</sup>Anthropology, Dartmouth College, <sup>6</sup>Biological Sciences, Dartmouth College

Variation among humans and other primates in ability to metabolize ethanol has reignited interest in the role this alcohol plays in shaping primate nutritional ecology, feeding preferences, and adaptation. Increased consumption of foods with high ethanol content has been hypothesized to favor mutations in genes underlying alcohol dehydrogenase (ADH) pathways to quicken ethanol catalysis in some great apes, including humans, and independently in aye-ayes. We further explore this hypothesis by examining *ADH1* and *ADH4* gene sequences across the grandorder Euarachonta in 12 species not previously examined (N = 8 treeshrews, 1 colugo, 3 primates), including those reported to consume large quantities of fermented nectar, the slow loris (*Nycticebus coucang*) and the penta-tailed treeshrew (*Ptilocercus lowii*). For all species examined, the  $d_N/d_S$  ratio is < 1 for *ADH1* and *ADH4*, indicating these genes are under purifying selection. Slow lorises do not share the  $\Delta_{294V}$  mutation that unites the derived forms of the ape and aye-aye *ADH4* gene; if slow loris ethanol metabolism is enhanced relative to other primates, it is by a novel route. Sequencing efforts are ongoing for *P. lowii ADH4* exon 7, which contains site 294; however, other exons in this gene appear to be under purifying selection. Understanding the genetic causes of variable ethanol metabolism efficiency in euarchontans will place human variation in a wider evolutionary framework and improve our ability to interpret this variation and identify its roots.

*This study was funded by the Alberta Children's Hospital Research Institute and the University of Calgary (to ADM).*

### Body size as a factor in skeletal age estimation: When size matters and how to deal with it

CATHERINE E. MERRITT

Centre for Anatomy and Human Identification, University of Dundee

There are many confounding factors that affect our ability to accurately estimate skeletal age at death. While factors such as sex and ancestry are important, body size may account for much of this variation. Research has shown that lighter body mass is associated with decelerated skeletal aging while heavier body mass is associated with accelerated skeletal aging. While it is not possible to form a precise body mass estimate from skeletal remains, it is often possible to estimate the relative size of an individual (e.g. light, average-range, or heavy body mass). For example, clothing found on or near the remains in forensic contexts; known average population sizes at archaeological sites; and osteological markers correlated with obesity may be used.

This is the first time recommendations are provided on how to adjust final age estimates to accommodate for body size, and how this results in more precise age estimates. Two case studies of individuals from the Hamann-Todd and Bass Collections with light and heavy body masses are used. Ages are assessed with the Suchey-Brooks pubic symphysis, Lovejoy et al. auricular surface, and İşcan et al. fourth rib methods. The mean ages of these methods show body mass biases, with light individuals typically under-aged 5 to 8 years compared to heavy individuals, and heavy individuals over-aged by 3 to 10 years compared to light individuals. When age ranges from these methods are adjusted to account for these differences, the resulting final age estimates more precisely reflect the individual's actual age at death.

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### Sexual Dimorphism of the Capitate using 3D Data

JANA V. MEYER<sup>1</sup>, HEATHER J.H. EDGAR<sup>1,2</sup>, SHAMSI DANESHVARI BERRY<sup>3</sup> and WILLIAM F. MARQUARDT<sup>1</sup>

<sup>1</sup>Anthropology, University of New Mexico, <sup>2</sup>Maxwell Museum of Anthropology, University of New Mexico, <sup>3</sup>Medical Center, University of Mississippi

This pilot study explores the potential of using 3-dimensional data from capitates for the sex assessment of unknown individuals. A sample of left capitates from 12 adult males and 14 adult females of European-American ancestry were chosen from the documented collection

of the Maxwell Museum of Anthropology at the University of New Mexico. These bones were scanned with an HDI Advance white light scanner to obtain high-resolution 3D models of the bones. Measurements included total volume and surface area, as well as surface areas of articular surfaces alone and in combinations. Discriminant function analysis was used to develop an equation for sex estimation for these 26 individuals. The most successful equation includes the capitate volume and the combined articular surface areas for the lunate and scaphoid. In the internal sample this led to an accuracy of 100% for females (14/14) and 91.67% (11/12) for males. Other combinations of volume with different articular surface areas provided identical results for females but a reduced accuracy in males (83.33%; 10/12). The most accurate equation classified 80% accurately (4/5) for both males and females in an additional sample (n=10, equal males and females).

This approach presents a novel addition to current sex assessment methods through the use of 3D data (including volume and surface area), increasing the options for sex assessments of previously indeterminate individuals. This is of special importance for fields like forensic anthropology and bioarchaeology, where the discovery of incomplete sets of human remains is frequently encountered.

### How did early hominins hold their heads? New evidence on head posture from the australopith cervical spine

MARC R. MEYER<sup>1</sup> and SCOTT A. WILLIAMS<sup>2,3,4</sup>

<sup>1</sup>Department of Anthropology, Chaffey College, <sup>2</sup>Center for the Study of Human Origins, Department of Anthropology, New York University, <sup>3</sup>New York Consortium in Evolutionary Primatology, <sup>4</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand

Considered individually, many aspects of early hominin cervical anatomy appear more similar to the African great apes than to humans, suggesting an ape-like pattern of load transfer, and by extension points to significant differences with human head carriage.

However, when the australopith cervical spine is examined as a whole, rather than as separate isolated elements, a more human-like pattern emerges. In this context anatomical differences appear to have only insignificant functional implications and may be explained as developmental reciprocates of cranial base morphogenesis. Corroborating this observation is a nearly complete series of new cervical vertebrae from *Australopithecus afarensis* (KSD-VP-1/1) from Woranso-Mille, Ethiopia, dated to ~3.6 million years before present, which we compare to a sample of *Homo sapiens* (N=57), *Pan troglodytes* (20), *Gorilla gorilla* (20) *Au. afarensis* (2) *Au. sediba*

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(2), *Homo erectus* (2), Pleistocene hominins from Sima de los Huesos (3), and Neandertals (7).

The new *Au. afarensis* fossils from Woranso-Mille reveal an aggregate biomechanical and entheso-pathological signature typical of *Homo sapiens* and present a surprisingly human-like kinematic signal. These lines of evidence evince a mode of head posture in early hominins very similar to modern humans as early as 3.6 million years ago.

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### Revisiting the Early Miocene Paleoenvironments of Rusinga Island, Lake Victoria, Kenya based on Paleosols and Paleontological Analyses

LAUREN A. MICHEL<sup>1</sup>, KIERAN P. MCNULTY<sup>2</sup>, THOMAS LEHMANN<sup>3</sup>, ALICE NOVELLO<sup>4</sup>, STEVE G. DRIESE<sup>5</sup>, DAVID L. FOX<sup>6</sup>, NICOLE D. GARRETT<sup>2</sup> and DANIEL J. PEPPE<sup>5</sup>

<sup>1</sup>Department of Earth Sciences, Tennessee Tech University, <sup>2</sup>Department of Anthropology, University of Minnesota, <sup>3</sup>Paleoanthropology and Messel Research, Senckenberg Research Institute and Natural History Museum, <sup>4</sup>Department of Biology, University of Washington, <sup>5</sup>Department of Geosciences, Baylor University, <sup>6</sup>Department of Geology and Geophysics, University of Minnesota

The Early Miocene rocks from Rusinga and Mfangano Islands, Lake Victoria, Kenya are among the best-studied deposits yielding evidence related to early hominoid evolution. However, until recently the dates of the Rusinga Group deposits have been debated, hindering accurate correlations and interpretations. Additionally, the paleoenvironmental reconstructions ranged from closed and ever-wet to more open and semi-arid, which was based on either single proxy reconstructions from strata not associated with vertebrate fossils or on biased, time-averaged faunal assemblages or stratigraphic intervals. Here we report new paleoenvironmental interpretations based on a multiproxy approach.

In particular, the paleosols from the Wayando, Kiahera and Hiwegi Formations are discussed and their paleoenvironments are reconstructed using field and laboratory analyses. Fieldwork reveals four distinct pedotypes (Calcic Protosol, Calcisol, Protosol, and Vertisol) that are placed throughout the stratigraphy. The Wayando Formation is exclusively composed of Calcic Protosols. The Kiahera Formation contains both Calcisols and Vertisols, and the Hiwegi Formation has both Calcic Protosols and Protosols. These different pedotypes represent at least three different paleoenvironments and probably record environment oscillating between open and closed throughout the time of Rusinga Group deposition. The paleoenvironmental interpretation is confirmed through comparison with paleobotanical proxies and faunal assemblages. Importantly, the presence of multiple paleoenvironments within traditional fossil collecting

areas is a strong indication that locality-based assemblages are likely sampling more than one paleoenvironment in some cases. This research, in combination with faunal and paleobotanical studies, provides further evidence that Rusinga's catarrhine communities were able to live in a variety of habitats.

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### Functional inferences from vertebral morphology and torso shape in anthropoids

EMILY R. MIDDLETON and CAROL V. WARD  
Pathology and Anatomical Sciences, University of Missouri

Hypotheses about torso shape differences among anthropoids have centered on shoulder orientation, where the dorsally-positioned scapulae of apes led to broader thoraces, stiffer spines, and broader pelves compared to monkeys. Although argued to constitute one adaptive package for below-branch suspension, the range of behaviors among hominoids indicates that the functional relationships among these regions deserve closer inspection. Here we compare the thoracolumbar vertebrae and pelvis to explore how iliac morphology varies across taxa and tracks functional morphology of the spine.

Landmark data were collected on thoracic and lumbar vertebrae and articulated pelves from over 160 anthropoid specimens sampling all major clades. The importance of vertebral anatomy to pelvic form is highlighted by the fact that, contrary to expectations, ilia are minimally broader in apes than in monkeys and are not rotated. Rather, the iliac fossa lies in equivalent orientation in all anthropoids, and it is the narrower iliac tuberosities and narrower spacing of the dorsal ilia in apes that create the impression of rotation. Principal Components Analysis demonstrates that, as expected based on pelvic form, great apes differ from most monkeys in lumbar transverse process position and spinous process orientation, with *Ateles* and hylobatids intermediate. Data also reveal previously unappreciated differences among monkey clades and show that patterns of 3D shape vary among taxa along the vertebral column. Our results suggest that spinal musculature and function have a greater effect on pelvic morphology than does shoulder orientation, and that there is greater interspecific variation throughout the torso than previously appreciated.

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### Who, What, Where: Patterns of Gut Microbial Diversity in Atelines

KRISTA M. MILICH<sup>1</sup>, KATHERINE R. AMATO<sup>2</sup>, ANDRES LINK<sup>3,4</sup> and ANTHONY DI FIORE<sup>1,4</sup>

<sup>1</sup>Anthropology, University of Texas at Austin, <sup>2</sup>Anthropology, Northwestern University, <sup>3</sup>Department of Biological Sciences and School of Management, Universidad de Los Andes, <sup>4</sup>Fundación Proyecto Primates, Fundación Proyecto Primates

Microbial communities are shaped by the environment, genetics, diet, social interactions, and many other factors. Here we use a multi-species, multi-site, multi-group comparison to examine the relationship between an individual's gut microbiome and its geographic location, phylogenetic classification, and social group membership. We hypothesized that an individual's gut microbiome would be more similar to: 1) other individuals of the same species compared to those of different species, 2) members of the same social group compared to other social groups, and 3) individuals living at the same field site compared to those at a different field sites. Fecal samples were collected from four species of atelines across two field sites, including *Ateles belzebuth* and *Lagothrix lagotricha* from the Yasuni Biosphere Reserve in Ecuador, *Ateles hybridus* from San Juan de Carare in Colombia, and *Alouatta seniculus* from both sites. We used high throughput analyses of 16S microbial rDNA and shotgun metagenomic sequencing to characterize the microbial communities. Our data support the first two hypotheses: individuals of the same species had more similar gut microbiota than those of different species, and within each species, individuals in the same social groups had more similar gut microbiota than those from different groups. While geographic location can shape gut microbial communities, the two populations of *Alouatta seniculus* were more similar to each other than either were to other species at their respective sites. These findings suggest that phylogenetic, environmental, and social factors should be incorporated into models to understand variation in primate gut microbial ecology.

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### Gender differences in diet and physical activity: Evidence of social difference in a Muisca community (Sabana de Bogotá, Colombia, 1000-1400 AD)

MELANIE J. MILLER<sup>1</sup>, SABRINA C. AGARWAL<sup>1</sup> and CARL H. LANGEBAEK<sup>2</sup>

<sup>1</sup>Anthropology, UC Berkeley, <sup>2</sup>Antropología, Universidad de los Andes, Bogotá, Colombia

The Muisca cultural group occupied a large territory in the northern Andes, in the Sabana de Bogotá, Colombia, from 800-1600 AD. The

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Muisca are often characterized as an emergent complex chiefdom with rigid social hierarchies that characterized social relationships. Recent bioarchaeological work has revealed that social status may not have been the only or principle axis of differentiation that was operating within Muisca society, and that gender differences may have been a prominent biosocial variable that differentiated groups. A sample of 199 individuals from the Muisca archaeological site of Tibanica (Soacha, Colombia, 1000-1400 AD) was analyzed for diet (via stable isotope analysis of bone and tooth,  $n=199$ ), and activity patterns (via cross-sectional geometry of femurs,  $n=63$ , and humeri,  $n=33$ ). The isotopic data indicates significant dietary differences between males and females, with males having greater access to maize (a  $C_4$  crop) over their whole lifetime (from childhood to adulthood) in comparison to females, who consumed less maize. The Tibanica males have more robust femurs, possibly related to agricultural work, while the females have much stronger and more robust upper arms, likely related to food preparation activities such as grinding maize. We propose that the gender-divisions observed in labor and diet indicate that for the Muisca, gender was a very important and salient social variable that separated and united groups in daily patterns of behavior and activity.

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### The Osteological Paradox: Its Silver Jubilee

GEORGE R. MILNER<sup>1</sup> and JESPER L. BOLDSSEN<sup>2</sup>

<sup>1</sup>Anthropology, Pennsylvania State University,

<sup>2</sup>ADBOU, University of Southern Denmark

A quarter century ago an article, with Jim Wood as lead author, appeared that identified several problems with translating what bioarchaeologists observe (pathological lesions in skeletons) into something of interest (the disease experience of past living populations). Difficulties stem from heterogeneity in frailty among living people and mortality acting selectively on that heterogeneity. In short, everyone at each age does not experience the same risk of dying, so cemeteries are filled with people who were sick and malnourished when they died. Here we cover several substantive efforts to address these difficulties and the present outlook for a quantitatively rigorous paleoepidemiology.

Noteworthy developments include a means of estimating the surplus risk of dying with specific pathological conditions using a three-state model, and its use to examine the degree to which catastrophic (plague) mortality was selective insofar as prior conditions were concerned. More recently, the relative risk of dying with healed trauma was estimated through a simulation

based on age-at-death and injury frequencies in the original skeletal sample.

Paleoepidemiological studies featuring estimates of the relative risk of dying potentially bridge the gap between skeletal studies and analyses of medical records. That will permit a closer integration of bioarchaeological research and studies of modern peoples, and thereby further our understanding of changes over time in host-pathogen relationships and human mortality. The field must shift from skeletal lesion frequencies in mortality samples to estimates of disease prevalence in the past and the relative risk of dying with various pathological conditions.

### The Impact of Multiple Skeletal Stress Markers on Survivorship and Longevity

JOCELYN D. MINSKY-ROWLAND

Anthropology, Cerritos College

Anthropologists concerned with the selective mortality of individuals often focus on the presence of skeletal indicators of stress to infer the health and survivorship of a population. The current project questions whether none, one, or multiple skeletal stress markers affects the survivorship of the Arikara Native Americans across four archaeological sites (AD 1600-1832). A total of 107 individuals, out of 347 discrete, adult individuals, were skeletally complete enough to be analyzed for age, sex and the co-occurrence of antemortem physiological stress markers including: linear enamel hypoplasias, porous skull lesions and short stature. Previously, no statically significant survivorship differences between individuals, with or without at least one skeletal stress marker, were documented. In the current project, Kaplan-Meier estimates with log-rank tests were conducted in SPSS version 22. While statistically significant results for females were not documented, the associated survivorship curves suggest that females with multiple stress markers exhibit a decrease in survivorship when compared to females lacking a stress marker or when compared to those with at least one stress marker. Males with multiple stress markers do exhibit a statistically significant decrease in survivorship compared to those with one or no stress markers. These results not only further document the differential survivorship of the two sexes in this subsample, they also suggest that it may be more informative to analyze survivorship and selective mortality in the context of multiple stress markers.

### Aging using adult human pelvis morphology: effect of occupation or statistical method?

MOLLY MIRANKER

Consultant Researcher, Argentine Forensic Anthropology Team

Most previous studies assessing the influence of physical activity (approximated by occupation) on pelvic age indicators have been performed on European skeletal collections. This study used a modern American collection to test whether occupation has similar effects on pelvic aging between populations, geographically and temporally.

The Suchey-Brooks, Osborne, Calce, and Rissech pelvic aging methods were applied to 203 white individuals (127 male, 76 female) from the Bass Donated Skeletal Collection. Occupations were categorized "manual" or "non-manual" based on antemortem data. Spearman's correlations examined the strength of the relationship between estimated and actual age, and analyses of covariance (ANCOVA) tested the potential influence occupation had on the estimated age.

The study found high Spearman's correlations between the estimated and actual age regardless of sex or occupation. Exceptions were observed for manual occupation type females for Suchey-Brooks ( $r_s=0.447$ ,  $p=0.072$ ), Osborne ( $r_s=0.266$ ,  $p=0.319$ ) and Calce ( $r_s=0.397$ ,  $p=0.114$ ). The overall relatively high correlations ( $r_s>0.40$ ) suggested the relationship between estimated and actual age may not be influenced by occupation. For all aging methods and both sexes the ANCOVA tests showed estimated age was not affected by occupation ( $p>0.05$ ).

Given the non-significant results comparisons could not be made to the European studies. These results suggest occupation is not influential to pelvic age-related changes. Further exploration of ways the results may depend on subjective categorization of occupation data, or on the use of occupation as an approximation of life activities, should be conducted.

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### Osteon circularity variation with femur size and anatomical region in archaeological humans

PAULA FUENTE GARCÍA<sup>1</sup>, JUSTYNA J. MISZKIEWICZ<sup>2</sup>, CHRIS DETER<sup>1</sup> and PATRICK MAHONEY<sup>1</sup>

<sup>1</sup>Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent,

<sup>2</sup>School of Archaeology and Anthropology, Australian National University

It has been recently suggested that the circularity of secondary osteons (On.Cr) may be useful in determining biomechanical loading history from long bone microstructure. However, the variability of On.Cr in adult human cortical bone requires investigation to inform future methods. We studied femora from 15 medieval adult males to test whether On.Cr variation occurs with bone size and anatomical region.

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Sex and age-at-death were determined following standard methods. Classic macro-morphometric and cortical measurements were collected to group the femora into gracile ( $n = 8$ ) and robust ( $n = 7$ ) categories. Bone microstructure was examined in thin sections removed from the anterior and posterior midshaft. Using ImageJ, On.Cr index values were measured for an average of 30 osteons per thin section.

Osteons were significantly more circular in the gracile than in the robust femora when both anatomical regions were pooled ( $p = .000$ ), as well as when comparing anterior ( $p = .001$ ) and posterior ( $p = .001$ ) osteons. A subsequent related-samples analysis revealed that anterior osteons were significantly more circular than those from the posterior region in the gracile category only ( $p = .028$ ).

Results indicate that two-dimensional cross-sectional shape of secondary osteons varies with bone size. This may be in part related to mechanical strain differences associated with skeletal remodeling and modeling. Our analysis also suggests that On.Cr may be affected by sampling location as a result of localized remodeling in adult cortex.

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### Ancient Parasites and Transition: Using Intestinal Infections to Track the Impact of Human Lifestyle Change

PIERS D. MITCHELL

Archaeology and Anthropology, University of Cambridge

It has long been noted that the risk of infection by different species of parasites depends upon the lifestyle humans lead as well as the region in the world in which they live. When modern hunter-gatherers change lifestyle to become farmers, in just a few decades the population changes from intestinal infection with zoonotic parasites they contract from eating wild animals, to geohelminths such as roundworm, whipworm, hookworm and pinworm that are spread by fecal contamination of hands and food. In consequence, we would expect a similar change in the first epidemiologic transition when prehistoric humans first took this step.

However, in a significant number of regions the archaeological evidence does not match what we might expect. In the Americas pinworm became more common after early populations started to farm, but unexpectedly roundworm and whipworm only started to become common much later when Europeans arrived (c. 1500s AD). In Japan roundworm became common in the Yayoi period (400 BC – 300 AD) once rice farming was introduced, but unexpectedly whipworm was already common in the hunter-gatherers (4,000-1,500 BP) well before farming was introduced. In Europe, the only example of intestinal parasite infection in hunter-gatherers found to date was

not a zoonosis, but roundworm. This is the opposite of what we might expect. All this evidence contrasts with traditional theory, and suggests that the past disease environment was much more complex than the epidemiologic transitions hypothesis might lead us to believe.

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### Analysis of central american machete cut marks: an application of microprofilometry and micro-computed tomography

SAMANTHA MITCHELL<sup>1</sup>, ANNA NOVOTNY<sup>1</sup> and PATRICK LEWIS<sup>2</sup>

<sup>1</sup>Sociology, Anthropology, and Social Work, Texas Tech University, <sup>2</sup>Biological Sciences, Sam Houston State University

Analysis of sharp force trauma indicate the machete as a tool frequently used in violent altercations across Central America, South America, and Mexico. Reports indicate that the machete is connected to varied forms of interpersonal violence and is used as a means of intimidation for organized crime syndicates. Notably, machetes manufactured within Central America vary significantly from machetes manufactured within the United States, including variability in blade width and length. However, a quantifiable method has yet to be developed to address cutmarks made by machetes produced within Central America. Thus, this study utilizes micro-computed tomography (micro-CT) to quantify the microstructure of machete cutmarks by assessing the uniformity of cutmark profiles produced using a Central American machete. A series of cuts were completed on three human cadavers obtained through the South East Texas Applied Forensic Facility (STAFS). Resulting sectioned and non-sectioned skeletal elements were scanned at the University of Texas High Resolution CT Facility. Cross-sectional analysis tested for mean deviance of cutmark profiles and statistical variance of machete class characteristics across samples. This study found micro-CT to be an invaluable tool for the standardization of quantifiable cutmark research. Statistical analysis indicates variability in machete cutmarks between samples and within skeletal groups. Results indicate the Central American machete creates a unique cutmark, however, consistency of cutmark profiles vary significantly and inhibit application of traditional class characteristics. This poster presents the statistical results of micromorphological analysis and discusses the advantages and shortcomings of utilizing micro-CT technology for cutmark analysis.

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### The "cliff edge model" of human obstetric selection

PHILIPP MITTEROECKER

Department of Theoretical Biology, University of Vienna

The incidence of obstructed labor in humans is strikingly high, in the range of 3-6% worldwide. Most of these cases result from the misfit of the mother's pelvic dimensions to the newborn's head. Mortality and morbidity due to cephalopelvic disproportion imposes a strong – and partly persisting – selection pressure. The question why natural selection has not led to a wider female birth canal and reduced obstructed labor remains a puzzle in evolutionary anthropology.

I present a new model that explains the high rate of obstructed labor by the very specific properties of the selection scenario involved in human childbirth. Central to this explanation is the "cliff-edged" fitness function associated with the difference between neonatal head size and maternal pelvic canal size: fitness continually increases until it drops sharply when the neonate cannot pass through the mother's pelvis any more. By contrast, the dimensions of the head and the pelvis tend to be symmetrically distributed. For that reason, the optimal symmetric phenotype distribution always involves a fraction of individuals beyond the "fitness edge", i.e., with cephalopelvic disproportion.

Drawing from evolutionary quantitative genetics, the model allows for an estimation of the selection gradient on neonatal and maternal dimensions. I show that moderate directional selection suffices to account for the high rates of cephalopelvic disproportion and discuss why selection is unable to reduce these rates. Furthermore, the model predicts a considerable evolutionary response of pelvic and/or neonatal dimensions to obstetric selection during the last decades, when Caesarean sections have been widely used.

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### Cospeciation of Gut Microbiota with Hominids

ANDREW H. MOELLER<sup>1</sup>, BEATRICE H. HAHN<sup>2</sup>, ANNE E. PUSEY<sup>3</sup>, ELIZABETH V. LONSDORF<sup>4</sup>, MARTIN N. MULLER<sup>5</sup>, ALEXANDER V. GEORGIEV<sup>6</sup> and HOWARD OCHMAN<sup>7</sup>

<sup>1</sup>Miller Institute for Basic Research in Science, UC Berkeley, <sup>2</sup>Perelman School of Medicine, UPenn, <sup>3</sup>Department of Anthropology, Duke University, <sup>4</sup>Department of Psychology and Biological Foundations of Behavior Program, Franklin and Marshall College, <sup>5</sup>Department of Anthropology, University of New Mexico, <sup>6</sup>Department of Anthropology, Northwestern University, <sup>7</sup>Integrative Biology, UT Austin

Humans harbor a multitude of bacteria that are deeply integrated with a wide range of phenotypes, but the evolutionary origins of the bacterial lineages that populate humans are unknown. Here we show that multiple lineages of the predominant bacterial taxa in the human gut arose via cospeciation with humans, chimpanzees, bonobos, and gorillas over the past 15 million years. Gyrase-B amplicon sequencing

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of strain-level bacterial diversity within the gut microbiomes of 120 individual hominid hosts revealed that clades of Bacteroidaceae and Bifidobacteriaceae have been maintained exclusively within host lineages across hundreds of thousands of host generations. Divergence times of these cospeciating gut bacteria are congruent with those of hominids, indicating that nuclear, mitochondrial, and gut bacterial genomes diversified in concert during hominid evolution. In addition, fine-scale phylogenetic analyses revealed Bacteroidaceae and Bifidobacteriaceae lineages that diversified alongside human populations during the migration out of Africa. This study identifies human gut bacteria descended from ancient symbionts that speciated simultaneously with humans and the African apes.

### A lesson in stressin': A comparison of linear enamel hypoplasias in children from the prehistoric Ohio Valley

EMILY MOES and SAMANTHA BLATT  
Anthropology, Boise State University

When constructing patterns of health regarding physiological stress in past populations, it is necessary to include multiple factors of the stress experience, rather than relying on comparisons of subsistence strategy alone. Linear enamel hypoplasias (LEH) provide a unique insight into stress because enamel does not remodel throughout life, therefore preserving an accurate record of developmental disruption. This project compares the time and duration of stress events of three samples by examining the permanent anterior teeth of children (n=40) from a foraging group (4000-3000 BP) and two agricultural populations (A.D. 1000-1500). Through highly accurate dental cellular histology, the ages-at-death of these children were previously determined. A scanning electron microscope was used to create 50X photomontages of micrograph images of replicas of each tooth surface. The location and number of LEH was recorded from these photomontages by concurrently matching defects among other teeth from the same individual. To calculate the ages at which stress events occurred, perikymata (pk) were counted from the occlusal surface of each tooth to the beginning of each identified LEH, then added to cuspal enamel formation, and initiation times for each tooth. Duration of each event was reflected in the total number of pk within each defect furrow. These variables were compared between samples using Fisher's exact tests, pairwise ANOVA tests, and averages. Agricultural children endured the most stress events, but the foraging children suffered the longest stress events. The resulting variation is attributable to cultural or nutritional changes between foragers and agriculturalists in the Ohio Valley.

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### The Effect of Obstetric Demand on the Magnitude of Sexual Dimorphism in the Birth Canals of Anthropoid Primates

ELIZABETH A. MOFFETT  
Anthropology, Stony Brook University, Pathology and Anatomical Sciences, University of Missouri

Though selection for birth is thought to result in dramatic dimorphism in the birth canals of humans, previous studies have indicated that many species of anthropoids have dimorphic pelvises, not just those that give birth to relatively large-headed neonates. This prompts several questions: (1) are there factors other than birth which influence dimorphism in non-human primate pelvises; (2) does obstetric demand relate to the magnitude of dimorphism in anthropoid pelvises; and (3) is there anything unusual about the level of pelvic dimorphism that exists in humans?

This study tests the hypothesis that large cephalopelvic proportions influence the magnitude of dimorphism in the size and shape of the birth canal. Landmark data for 920 anthropoid specimens were analyzed [Large cephalopelvic proportions: *Homo sapiens* (n=156), *Hylobates lar* (n=112), *Macaca mulatta* (n=187), *Nasalis larvatus* (n=33), *Papio anubis* (n=21); *Saimiri sciureus* (n=153); Small cephalopelvic proportions: *Alouatta seniculus* (n=38), *Gorilla gorilla* (n=106), *Pan troglodytes* (n=114)]. Results indicate that most species have some level of birth canal dimorphism such that females have larger and transversely wider birth canals than males (p<0.05). However, the magnitude of dimorphism is greater among species with large cephalopelvic proportions compared to taxa with small proportions. Body size dimorphism also influences dimorphism in the birth canal - species with both large cephalopelvic proportions and high levels of body size dimorphism have the highest magnitudes of pelvic dimorphism. Finally, humans have more birth canal dimorphism than would be expected based on our cephalopelvic proportions or body size dimorphism.

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### Stable isotope analyses of human bone collagen from Iron Age Switzerland - Diet and mobility of Swiss "Celtic" populations

NEGAHNAZ MOGHADDAM<sup>1</sup>, FELIX MÜLLER<sup>2</sup> and SANDRA LÖSCH<sup>1</sup>

<sup>1</sup>Department of Physical Anthropology, Institute of Forensic Medicine, University of Bern, Switzerland,

<sup>2</sup>Department of Prehistory, Institute of Archaeological Sciences, University of Bern, Switzerland

Stable isotopes are ideal tracers in biological systems as they do not decay over time. Isotopic analyses of human bone collagen provide information on diet, social stratigraphy and migration. Data from the Late Iron Age burial site of Münsingen revealed sex and age related differences. However, it might be expected that Late Iron Age populations at different regions had distinct subsistence strategies due to varying socio-economic living and/or environmental conditions. Stable isotope ratios ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ , and  $\delta^{34}\text{S}$ ) of human remains (N = 164) from 11 different Iron Age sites were analyzed. The data show significant differences between the burial sites, with higher  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values ( $p = 0.000^{***}$ ) in the southern Alpine regions compared to the Swiss Plateau north of the Alps. Stable carbon isotope data suggest a diet mainly based on plant sources following the  $\text{C}_3$  photosynthetic pathway. However, more positive  $\delta^{13}\text{C}$  values in the Alpine regions indicate a higher intake of millet than in the Swiss Plateau. Additionally, stable nitrogen isotopes suggest a higher intake of animal protein for the individuals from the Alps. Distinct patterns of crop cultivation and animal husbandry might have led to different dietary habits. The southern area could have been under a stronger influence by the Mediterranean culture. Trade and cultural exchange, which probably were facilitated through migration as indicated by the  $\delta^{34}\text{S}$  values, should be taken into consideration. Furthermore, isotopic research leads to the suggestion that the Münsingen population might have had a predominant status during the Iron Age.

This project was funded by the Swiss National Science Foundation (CR1313\_149583)

### A technological study of the lithic artefacts from the Earlier Stone Age site of Maropeng in the Cradle of Humankind, South Africa

ROSA MOLL, KATHLEEN KUMAN and DOMINIC STRATFORD

Archaeology, University of the Witwatersrand

Maropeng is the only known open-air Earlier Stone Age site in the Cradle of Humankind, South Africa. Excavations by the authors revealed the largest Earlier Acheulean assemblage in the Cradle of Humankind, with just over 1000 artefacts. This represents a small sample of the artefact-bearing horizon, which is estimated to cover an area of approximately 191200m<sup>2</sup>. The assemblage is dominated by large cores and flakes, mainly on locally sourced quartzites. A combination of site formation processes have led to the removal of small flaking debris, thus the previous analysis (Pollarolo *et al.* 2010) focused on large cutting tools and cores. Here we present

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results from a detailed core reduction analysis of all the artefacts and tools, and technological components that aimed to provide a more definitive understanding of the techno-complexes represented at the site and test Pollarolo's hypothesis. Results show that cores have been reduced following naturally available platforms. However, the majority of flakes are not directly associated to the cores and represent different stages of reduction to the majority of cores. This may be due to site formation processes but could be due to time averaged mixing. Cores with large side struck removals represent only a part of the core assemblage. Associated flakes are mainly used as blanks for large cutting tools. Overall, the limited reduction and raw material exploitation, with variable reduction patterns suggests a prolonged early Acheulean accumulated assemblage, which indicates a long habitation of the landscape.

### An assessment of oral health in prehistoric Ancón, Peru

CAITLIN MONESMITH

Department of Anthropology, University of Illinois at Chicago

This project is a dental analysis of 110 crania and mandibles from the Field Museum of Natural History's holdings from Ancón, Peru, dated to the Middle Horizon (AD 600-1000) and Late Intermediate Period (AD 1000-1476). I investigated the occurrence of oral disease within the population and determined the overall prevalence of carious lesions, dental abscesses, and periodontal disease. The crania were scored for carious lesion prevalence, severity, and position, as well as for dental calculus using a combination of Buikstra and Ubelaker's 1994 standards and an adjusted version of the Ribiero scale to account for depth of buildup. Dental abscesses and periodontal diseases were also recorded per Buikstra and Ubelaker 1994. The residents were generally healthy with little skeletal trauma or pathology. However, oral pathologies unrelated to trauma or diseases that would leave traces in the rest of the skeleton can arise in an otherwise healthy population. This was the case at Ancón; more than 60% of the skeletal population exhibits carious lesions of varying severity and prevalence. Dental abscesses were rare, and periodontal disease was also atypical, but carious lesions were a major health factor throughout the population. Chi-square tests were used to determine any association with sex and carious lesions, which can be a determining factor in caries prevalence, but caries rates did not vary significantly (when  $\chi^2=0.05$ ) between male and female skeletons, suggesting a similar cariogenic diet throughout the population. Differences in caries prevalence may be a result of a diachronic shift in diet.

### The Developmental Cascade Biases Dates of Evolutionary Change in the Dentition

CARRIE S. MONGLE<sup>1</sup>, ALLISON NESBITT<sup>1</sup>, JEROEN B. SMAERS<sup>2</sup> and FREDERICK E. GRINE<sup>2,3</sup>

<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University,

<sup>2</sup>Department of Anthropology, Stony Brook University,

<sup>3</sup>Department of Anatomy, Stony Brook University

Developmental processes are important mechanisms that enable evolutionary change. For example, patterns of morphological variability generated by developmental processes directly impact the population-level variation upon which natural selection can act. By patterning the variability of traits, developmental processes can also shape their potential 'evolvability', leading to differential rates of evolution. One such process is the inhibitory cascade, which regulates the development of mammalian molars. Previous studies have experimentally demonstrated that the sequential development of molar teeth is controlled by an auto-regulatory reiterative signaling pathway of 'activator' and 'inhibitor' molecules that influence relative molar size. It has been suggested that spacing differences in these signaling pathways will also manifest in accumulative morphological variation, such that small changes in earlier developing teeth result in much larger changes in later developing teeth. We test the hypothesis that development can pattern rates of evolution by biasing trait evolvability. We use phylogenetic comparative methods to measure rates of evolution (defined as the magnitude of undirected, stochastic change in a Brownian motion process) from mesiodistal and buccolingual diameters of the lower M1, M2 and M3 across a sample of 71 anthropoid primate species. Our results demonstrate that the M1 evolves at the slowest rate, the M2 is intermediate, and the M3 has the fastest, most variable rate of evolution. These results suggest that the inhibitory cascade shapes the pathway by which evolutionary change can occur along the dentition.

### The relationship between dental eruption sequence, phylogeny and life history in the evolution of primate dentition

TESLA A. MONSON<sup>1,2</sup> and LESLEA J. HLUŠKO<sup>1,2</sup>

<sup>1</sup>Department of Integrative Biology, UC Berkeley,

<sup>2</sup>Human Evolution Research Center, UC Berkeley

Dental eruption sequence has been used extensively in the interpretation of fossil primate life history, based largely on Schultz's Rule. The rule describes the tendency for adult premolars to erupt relatively early compared to molars in slow-growing, longer-lived species. The contrasting hypothesis, one that has garnered increasing support from work in both primate and non-primate groups, is that dental eruption sequence is a product of phylogeny. We fully tested both hypotheses: 1) Dental eruption sequence is

phylogenetically conserved, and, 2) Dental eruption sequence is correlated with life history variables like lifespan and body size (Schultz's Rule). We assessed post-canine dental eruption sequence in a sample of  $n=3,363$  extant primates, spanning 47 species and nine families, as well as an additional 22 primate species whose values were taken from the literature. The third molar erupts after the premolars in  $n=51$  of the species sampled, the premolars erupt after the third molar in  $n=15$  species, and we found variation in  $n=3$  species. Our ancestral state reconstruction supports the hypothesis that the third molar erupted last in the ancestor of Simiiformes with 90.8% likelihood, and that the premolars erupted last in the ancestor of Strepsirrhini with 89.9% likelihood. Dental eruption sequence in primates has a conserved phylogenetic signal ( $D=-0.0224$ ,  $p=0.007$ ). Additionally, phylogenetically independent contrast between dental eruption sequence and average maximum lifespan finds that these traits are not significantly associated in primates ( $p=0.603$ ). We also report on the correlation between dental eruption sequence and other life history and body size traits.

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### An Integrative Approach for Evaluating Rhesus Macaque Social Behavior: Whole Genome Sequencing Reveals Molecular Variation in a Suite of Neuroreceptors

MICHAEL J. MONTAGUE<sup>1</sup>, NOAH SNYDER-MACKLER<sup>2</sup>, SETH MADLON-KAY<sup>1</sup>, KARLI K. WATSON<sup>3</sup>, LAUREN J. BRENT<sup>4</sup>, J. H. SKENE<sup>5</sup>, JULIE E. HORVATH<sup>6</sup> and MICHAEL L. PLATT<sup>1</sup>

<sup>1</sup>Neuroscience, University of Pennsylvania,

<sup>2</sup>Evolutionary Anthropology, Duke University, <sup>3</sup>Institute for Cognitive Science, University of Colorado, Boulder,

<sup>4</sup>Centre for Research in Animal Behaviour, University of Exeter, <sup>5</sup>Duke Institute for Brain Sciences, Duke University, <sup>6</sup>Biological and Biomedical Sciences, North Carolina Central University

Evidence suggests that individual variation in social behavior arises from a combination of genetic predispositions and individual experience, yet the underlying biological mechanisms linking the two remain poorly understood. To address this gap, we seek to understand the genetic, developmental, and neurobiological contributions to social behavior in a population of rhesus macaques (*Macaca mulatta*) on Cayo Santiago island (Puerto Rico), which represents a large, free-ranging study sample with a known pedigree and well-characterized behavioral and cognitive phenotypes. We hypothesize that genetic variants underlying molecular differences in neuroreceptors are associated with distinct suites of behaviors in this socially complex species. To describe genetic variation, we generated whole genome sequences for 217 individuals using

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100bp Illumina paired-end libraries. The population was sequenced to a total genome coverage of 1240X (mean 5.7X per individual), and the reads were then aligned to the rhesus macaque reference genome. We implemented variant detection and identified over nineteen million single nucleotide variants in the population. This total included 346,972 exonic variants, of which 40% were predicted to alter transcript splicing sites or the translated protein sequences. Regarding the latter, amino acid changes were described in dopamine receptors, oxytocin and vasopressin receptors, serotonin transporters, and the opioid receptor,  $\mu$ -1 (*OPRM1*). We assessed the functional impact of these amino acid changes using computational tools that predict the potential damage of missense genetic mutations, finding neutral, tolerated and deleterious impacts on the receptor and transporter proteins. We posit that particular genetic variants within fundamental neurotransmitter pathways underlie social behavioral differences.

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### The impact of shared evolutionary history on the observed morphological differences in the femoral mid-shaft between archaic and modern humans

BRITTANY L. S. MOODY

Department of Anthropology, Texas A&M University

Multiple evolutionary and behavioral hypotheses have been proposed to explain the clear morphological differences in the femoral midshaft of early modern humans versus Neanderthals. With increased availability of aDNA data, it is possible to assess the role that shared evolutionary history may play in shaping this morphology. In order to test for phylogenetic signal, femoral cross-sectional data from the mid-shafts of 14 Neanderthals, 25 Late Pleistocene modern humans, and 146 recent modern humans from four different archaeological populations were analyzed using Procrustes superimposition. The resulting shape data was mapped onto a phylogenetic tree, using square-change parsimony, constructed from mitochondrial genomes from temporally and geographically comparable populations to the morphological data. The permutation test revealed significant phylogenetic signal between these groups related to shape changes in the femur. Independent Contrasts and multivariate regression analyses showed a lack of significant interdependence between evolutionary allometric and shape changes despite the presence of phylogenetic signal. This indicates that the observed variation in femoral cross-sectional morphology at the midshaft among Late Pleistocene humans is likely due to factors other than shared evolutionary history.

### Dental Health and Diet at Tell el-Amarna: A Comparison of Carious Lesions, Dental Wear, and Antemortem Tooth Loss in Dynastic Egypt

ERIKA L. MOREY

Anthropology, University of Arkansas

Bioarchaeological analyses of the inhabitants of Tell el-Amarna, Egypt, the capital city of Pharaoh Akhenaten (1349-1332 BCE), suggest that the diet of the typical Egyptian was high in cariogenic carbohydrates and moderately abrasive. This is in direct contradiction to the oft-repeated line that the ancient Egyptians had a highly abrasive diet which was low in carbohydrates. In order to better understand the relationship between the dental health of the Amarna population and that of the greater population of ancient Egypt, the current study compares dental health indicators (i.e., carious lesions, dental wear, and antemortem tooth loss) of the Amarna population with previously published data on Predynastic and Dynastic Egyptian dental health at various sites along the Nile Valley.

Other studies have suggested that carious lesions occur in between 2% and 16% of the adult population, with the highest rates reported in Third Intermediate and Late Period (1069-332 BCE) sites. At Amarna, carious lesions are present in all but the youngest (under 6) age category and occur in approximately 17% of all permanent molars ( $n=1746$ ). It is well established in the literature that carious lesions increase in frequency over Dynastic Egypt, and the Amarna population data hovers at the higher end of this spectrum, however, the population frequency of carious lesions in sites contemporaneous with Amarna is closer to 6%. This suggests that the population of Amarna had a diet which was unusual in the history of Egyptian civilization.

Funding provided by the Amarna Trust, King Fahd Center for Middle East Studies (University of Arkansas), National Geographic, and the Bioarchaeology Foundation.

### Shift in Dental Topography and Size in the Early Euprimate *Teilhardina* in Response to Climate Change at the End of the Paleocene-Eocene Thermal Maximum

PAUL E. MORSE<sup>1,2</sup>, DOUG M. BOYER<sup>3</sup> and JONATHAN I. BLOCH<sup>1</sup>

<sup>1</sup>Florida Museum of Natural History, University of Florida, <sup>2</sup>Department of Anthropology, University of Florida, <sup>3</sup>Department of Evolutionary Anthropology, Duke University

The earliest fossil euprimates appear in strata corresponding to a rapid, large-scale interval of global climate change, when temperature increased by  $>5^{\circ}\text{C}$  in less than 20 kyr and remained elevated for  $\sim 120$  kyr before cooling to background levels. Known as the Paleocene-Eocene Thermal Maximum (PETM), this event significantly altered North American floral composition

and is correlated with body size change in several mammalian lineages. The omomyiform euprimate *Teilhardina* first appears during the PETM and persists after it, though post-PETM cooling likely altered available dietary resources, forest structure, and mammal communities. To assess the effects of post-PETM cooling on size and diet within *Teilhardina*, we measured dental dimensions and topographic metrics that differ by dietary category among extant primates (relief index, slope, Dirichlet normal energy [DNE], and orientation patch count [OPC]) from microCT models of  $M_2$  crowns ( $N=26$ ) from a stratigraphically-controlled sample collected in the Bighorn Basin, Wyoming. No significant differences were observed for relief index, slope, or OPC. Tooth size increased slightly ( $<1\sigma$  from PETM mean), but significantly after the PETM ( $p<0.01$ , Mann-Whitney  $U$  test). DNE declined during the PETM, with lowest values corresponding to highest temperatures, then increased significantly during the cooling following the PETM ( $p=0.012$ )—a pattern paralleling changes in body size of some mammal lineages, such as horses. This increase in DNE exceeds the difference distinguishing broad dietary categories like frugivory and omnivory in extant prosimians, indicating that the cooling effects and associated changes following the PETM likely altered the feeding ecology of *Teilhardina*.

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### Variation in dietary intake and DNA methylation: The possibility of a remnant thrifty epigenotype in populations remaining at risk for seasonal food shortages

MJ MOSHER<sup>1,2</sup> and AARON J. WILLIAMS<sup>1</sup>

<sup>1</sup>Anthropology, Western Washington University, <sup>2</sup>Lab of Biological Anthropology, University of Kansas

Anthropologists hypothesize a human 'thrifty genotype' allowed ancestral populations to store energy when food was bountiful and survive famine. *LEP*, which produces leptin, an adipocyte-synthesized protein regulating appetite, energy storage and expenditure, is a major candidate gene; however, no allelic variant of *LEP* seems to explain the range of leptin expression among populations. DNA methylation responds to nutritional programming, potentially modulating gene expression to provide flexibility of adaptive responses in unstable nutritional environments. We hypothesize differential epigenetic signatures among populations suggest a 'thrifty epigenotype.' We examine the relationship of dietary intake to DNA methylation percentage at functional CpG sites (4 & 7) of *LEP* core promoter (C/EBP $\beta$ :TBS and TATA) and serum leptin levels in 182 individuals from two distinct populations: Siberian Buryat and Kansas Mennonite.

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Serum leptin is higher in females than males and lower in indigenous Buryat (M2.54/Fe7.3ng/ml) than US Mennonite (M6.4/Fe 16.0ng/ml). Mean percent DNA methylation at functional CpGs is greater in Buryat (62/38) than Mennonite (55/35) ( $p < 0.001$  for all per Mann-Whitney U). Macronutrient percent of diet was greater in carbohydrate and protein for Mennonite and higher in fat for Buryat. After log transforming appropriate variables, dietary percent of macronutrients were correlated with DNA methylation, with results significant in Buryat only. Percent of dietary protein correlates with functional CpGs ( $r = .375/p = 0.006$  and  $r = .409/p = 0.003$ ). Serum leptin correlates with percent fat and negatively with percent carbohydrate in Buryat only ( $r = 0.330/p = 0.017$  and  $r = -.367/p = 0.008$  respectively). *LEP* methylation correlating with differential energy intake in Buryat only implies a remnant thrifty epigenotype.

Wenner Gren Foundation for Anthropological Research, Western Washington University, and State of Kansas Attorney Settlement Fund.

### Attachment to older siblings can buffer the negative consequences of decreased maternal investment in wild infant olive baboons (*P. anubis*) in Laikipia, Kenya

CORINNA A. MOST and SHIRLEY C. STRUM  
Anthropology, UC San Diego

This project used long-term behavioral data to investigate the effects of decreased maternal investment on infant behavior in wild olive baboons. The study troop was followed for 12 months and focal data collected on 24 mother-infant dyads. For more than a decade, this troop has been exposed to a calorie-rich invasive cactus species (*Opuntia stricta*), whose fruits now comprise an important part of the animals' diet. Consequently, females in the troop have earlier age at first birth and shorter inter-birth intervals, with values similar to those of captive or crop-raiding baboons. They also show an overall reduction in maternal investment, as indicated by decreased infant carrying and earlier weaning. To investigate the effects of these changes, we collected data on infant social behavior and on rates of infant distress. We found that infants whose mothers began weaning earlier played less ( $p < 0.001$ ), and that infants whose mothers weaned them more aggressively engaged in less social behavior ( $p = 0.05$ ) and displayed higher rates of distress ( $p = 0.008$ ). However, infants that displayed attachment to an older sibling (as indicated by secure base behavior) played more ( $p = 0.001$ ) and showed less distress ( $p = 0.04$ ) than infants without this attachment. Although captive studies have demonstrated their ameliorating effect on severely socially deprived infants, alternative attachment figures are not often considered in discussions of wild primate behavior. These findings confirm that their

presence buffers the negative consequences of decreased maternal investment in the wild, and have implications for the evolution of alloparental care and cooperative breeding that characterize our species.

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### The origin of our species: an ancestral morphotype for modern humans

AURÉLIEN MOUNIER<sup>1,2</sup> and MARTA MIRAZÓN LAHR<sup>1,3</sup>

<sup>1</sup>The Leverhulme Centre for Human Evolutionary Studies, University of Cambridge, <sup>2</sup>UMR 7194 - Histoire Naturelle de l'Homme Préhistorique, Muséum national d'Histoire naturelle, Paris, <sup>3</sup>Turkana Basin Institute, Kenya

The origin of *H. sapiens* is a major focus in palaeoanthropology; yet, many unanswered questions remain. The morphological variation of Late Middle Pleistocene (LMP) African hominins is largely unknown, thus precluding the definition of boundaries of variability in early *H. sapiens*, and the interpretation of individual specimens.

This study uses maximum likelihood and 3D geometric morphometrics within a Brownian model of evolution to predict possible morphologies of a virtual last common ancestor (vLCA) of modern humans from a simplified phylogeny: early *Homo* (N=2), Neandertals (N=4), early *H. sapiens* (N=2), Africans (N=5), Eurasians (N=2) and Oceanians (N=2). Each specimen is described by 797 semi-landmarks.

The vLCA is computed as a set of shape coordinates used to warp a modern skull to obtain a fully rendered 3-dimensional shape of the predicted ancestral morphology. We compare the vLCA to LMP African fossils (KNM-ES 11693, Florisbad, Jebel Irhoud, Omo II, and LH 18) by aligning and scaling them (GPA) with the vLCA, in order to project them in morphospace, and to quantify shape differences between them and the vLCA (color-coded deviation spectrum) under various anatomical configurations.

Our results identify the strongest similarities between the vLCA and KNM-ES 11693 and Florisbad. Additionally, they underline the wide range of morphologies exhibited by the LMP fossils, some of which present stronger similarities with Neandertals or early *Homo* than with the vLCA. Such diversity may be explained by a complex transition towards modern humans, with chronological overlap between individuals showing a mosaic of derived and archaic traits.

This study was partially funded by the Fyssen Foundation, and an Advanced ERC Award (IN-AFRICA Project).

### Utilizing non-weight-bearing bones in archaeological investigations of the evolution of osteoporosis

REBECCA MOUNTAIN

School of Anthropology, University of Arizona

This paper examines the potential influence selection may have on the modern epidemiology of osteoporosis. A steady decline in bone strength since early *Homo* suggests a long-term evolutionary trend. This trend is often attributed to changes in human activity patterns, largely dismissing the potential for genetic change. Previous studies focused on weight-bearing bones, primarily affected by mechanical loading and therefore principally reflecting plasticity, rather than underlying alterations to the genotype. This study incorporates ribs—predominantly non-weight-bearing bones, largely influenced by genetics—to test the hypothesis that significant differences in BMD and bone strength are detectable between weight-bearing and non-weight-bearing bones in archaeological remains. Differences have the potential to reflect physical activity vs. genetic effects and suggest that non-weight-bearing bones could act as good indicators for evolutionary changes. BMD and polar strength strain indices (SSI) were compared in the femur, tibia, fibula, humerus, radius, and ulna, and a lower rib in a sample of 13 adult skeletons from a historic cemetery from Tucson, Arizona using peripheral quantitative computed tomography (pQCT). Results demonstrated significant differences in BMD and SSI between the rib and all six long bones ( $p < .001$ ). Significant differences were also found between the tibia and fibula ( $p < .01$ ). These results demonstrate the impact of differential load bearing on BMD and strength measurements in skeletal elements and the need to utilize both weight-bearing and non-weight-bearing bones to draw conclusions about the evolution of osteoporosis and human skeletal fragility.

### An ontogenetic perspective of the energetic contrains of brain growth on muscle mass

MAGDALENA N. MUCHLINSKI

Center for Anatomical Sciences, University of North Texas

The Growth Regulatory Hypothesis states that brain growth governs somatic growth. Muscle as a percentage of body mass (%TBM) varies during adulthood, but the amount of variation in muscle as a %TBM is most notable during early development. In humans, there is a marked inverse relationship between the rate of growth (and glucose consumption) in the brain and the rate of growth in skeletal muscle, with a pronounced shift in resource allocation directly preceding puberty. This shift occurs because early in life, brain growth is the focus of glucose consumption.

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This study evaluates if a similar relationship can be found in non-human primates. We collected body composition data (total muscle, bone, skin, fat, brain masses) on the following ontogenetic/adult sample of primates: *Pan*, *Pongo*, *Gorilla*, *Macaca*, *Papio*, *Trachypithecus*, *Pithecia*, *Alouatta*, *Saimiri*, *Callithrix*, *Eulemur*, *Varecia*, *Hapalemur*, *Galago*. Using molar eruption as a marker of adult brain size in subadults, we examined how muscle mass as a %TBM changes as individuals age. We observed a shift in muscle mass soon after the first lower molar erupts. In *Pan*, muscle as a %TBM averages 18% early in life, while it averaged 35% in adults. A similar pattern was documented among other primates (e.g., *Gorilla* 32 vs. 42%, *Papio* 22.7 vs. 38%, *Callithrix* 20.3 vs 33.2%, *Varecia* 23.74 vs. 38.4%, *Hapalemur* 15.11 vs. 24.2%). Examining how muscle mass changes ontogenetically is another method of evaluating the proposed metabolic trade-off between brain size and muscle mass.

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### Is primate sexual coloration an accurate indicator of immune functions?

MICHAEL P. MUEHLENBEIN<sup>1</sup>, SEAN P. PRALL<sup>1</sup>, ERIC C. SHATTUCK<sup>1</sup>, COREY S. SPARKS<sup>2</sup> and KATE C. BAKER<sup>3</sup>

<sup>1</sup>Anthropology, University of Texas at San Antonio,

<sup>2</sup>Demography, University of Texas at San Antonio,

<sup>3</sup>Veterinary Medicine, Tulane National Primate Research Center

Honest signals are those that are expressed proportional to emitter quality and cannot be misrepresented by lesser quality individuals; only the highest quality individuals should be able to invest maximally in survivorship and sexual ornamentation. It may be that secondary sexual characteristics, including pigmentation in several species of primates, are reliable indicators of survivorship that are maintained via hormones' antagonist pleiotropic interactions with the immune and reproductive systems. To understand how sex skin coloration is indicative of immunocompetence and endocrine function, rhesus macaques were sampled extensively at the Tulane National Primate Research Center across the breeding and birthing seasons (81 males in birthing, 46 in breeding; 99 females in birthing, 68 in breeding). Sampling included sex skin coloration assessed through spectrophotometry, complete anthropometry, various steroid hormones, and functional measures of immunity and inflammation. Body condition was operationalized using PCA; linear and linear mixed models were used to identify associations. In general, significant associations were identified only in animals when in good body condition: in both males and females of good body condition, sex skin coloration, immunity, and steroid hormone levels were associated with one another, tracking predictable changes across the birthing to

breeding seasons. Specific associations worth discussing include positive interactions between DHEA-S and serum bacteria killing ability in males, and testosterone and hemolytic complement activity in females. This study constitutes the first effort to analyze the interrelationships between endocrine function, sexual signals, and functional immunity in primates using sophisticated methods for measuring skin coloration and immunocompetence.

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### Evaluating Ecological Change in Western Madagascar: A Paleontological Perspective

KATHLEEN M. MULDOON

Anatomy, Midwestern University

Paleontological work in western Madagascar has yielded abundant remains of small mammals, the only direct means of comparing subfossil and extant assemblages on the island. By comparing "subfossil communities" with modern ones, the tempo and mode of community change can be established. My objectives were to reconstruct the paleoenvironments of western Madagascar, as reflected in the small mammal community, in order to decipher recent ecological changes that have taken place on the island. I identified approximately 10,000 mammalian subfossils from three western localities (Ankarana, late Pleistocene; Anjohibe, early Holocene; Ankiliteho, late Holocene). These collections are housed at the Université d'Antananarivo (Madagascar) and Duke University (USA). I assembled a database of extinct and still-extant small mammal occurrences for subfossil and modern localities across western Madagascar. These data were analyzed using ecological diversity analysis and spatial analysis software. Taxonomic and ecological comparisons were made in reference to a published database of 30 modern communities. Results indicate that in the deep past, western Madagascar likely supported small mammal communities that existed in more humid-type forest. More recent assemblages are similar extant communities in arid habitats. Despite changes in faunal composition, the overall trend indicates that the taxonomic and ecological structure of the small mammal communities are largely similar to communities of Western Madagascar today. Understanding how extinction influences extant community dynamics has important practical implications. The results of this project will help illuminate the many ways in which species are affected by dramatic changes to their ecosystem.

### Childhood Death in a Southwest Basketmaker II Community

DAWN M. MULHERN<sup>1</sup> and MONA C. CHARLES<sup>2</sup>

<sup>1</sup>Anthropology, Fort Lewis College, <sup>2</sup>Archaeology, Powderhorn Research

Mortuary practices can provide information about how communities define the boundaries between different stages of the life cycle. For example, in many cultures infants are considered "other" because they have not yet been integrated into society and maintain a place closer to the spirit world. As such, they may be treated differently in death. In a study of mortuary practices in 139 Basketmaker II individuals from 7 open sites and 1 alcove site in the Durango, Colorado area, several patterns were observed that shed light on how children were recognized in death. Children younger than 6 years were buried with fewer nonperishable grave goods compared to older children and adults. Biologically, six years represents a milestone in terms of dental and brain development associated with the ability to self-feed and perform more social and economic tasks. Puebloan societies also recognize a pre-adolescent period that involves greater social responsibility and increased cultural participation. Burial arrangement also resulted in some physical separation by age and sex. Several interesting case studies include a mummy of an adolescent male with burial treatment suggesting that he had not yet transitioned to his adult role in the community, still occupying the maternal sphere. Also, the two most elaborate burials of the entire assemblage were subadults that were probably females nearing the transition to adulthood.

### Genetics of risk and resilience in Syrian refugee youth

CONNIE J. MULLIGAN<sup>1</sup>, CHRIS CLUKAY<sup>1</sup>, JACKLYN QUINLAN<sup>1</sup>, RANA DAJANI<sup>2</sup>, DEEMA HAMADMAD<sup>3</sup>, GHUFRAN ABUDAYYEH<sup>3</sup> and CATHERINE PANTER-BRICK<sup>4</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Biology and Biotechnology, Hashemite University, <sup>3</sup>Research, Taghyeer Foundation, <sup>4</sup>Anthropology, Yale University

We evaluated a humanitarian program, designed to alleviate profound stress and build resilience, with a cohort of 297 Syrian refugee youth (11-18 years old) displaced to Jordan. We followed a randomized control design to compare psychosocial, biological, and cognitive function outcomes, over two cycles (spring/winter 2015) of program implementation. Syrian youth reported high levels of insecurity and trauma exposure, having experienced 6.36 lifetime trauma events, most notably seeing war bombardments (81%), forcibly-searched homes (72%), home demolition (55%), and wounded/dead bodies (54%).

Three genes associated in extant literature with childhood exposure to trauma and later development of aggression, depression, anxiety

## ABSTRACTS

and related characteristics were genotyped – monoamine oxidase A (*MAOA*), brain-derived neurotropic factor (*BDNF*), and fatty acid amide hydrolase (*FAAH*). A sample (n=208) of cheek swabs with pre-post intervention data for program cycle 2 were genotyped, with significant associations followed up with analysis of samples (n=77) from program cycle 1. Candidate gene alleles were tested for associations with a range of psychosocial outcome variables. High and low expression alleles of *MAOA* in males were found to significantly interact with number of traumatic events in association with symptom scores on Human Distress Index before the intervention (p=0.0005). *MAOA* alleles have been previously found to interact with childhood trauma in association with adult aggression and antisocial behavior in men. This work contributes to our understanding of how toxic stress may disrupt health and developmental trajectories for youth affected by war and forced displacement.

*The research was funded by the Wellcome Trust, DFID, and the University of Florida.*

### Multivariate Craniodental Allometry in Tarsiers (*Tarsius*), a Small-bodied, Cryptic, Insular Primate

RACHEL A. MUNDS and GREGORY E. BLOMQUIST  
Anthropology, University of Missouri

Evolutionary allometry describes size and shape differences across taxa matched for developmental stage (e.g. adulthood). Allometric studies can identify subtle differences among species, and therefore is invaluable to researchers interested in small-bodied, sometimes cryptic species such as tarsiers (*Tarsius*). Moreover, recent taxonomic revision has emphasized size differences among three possible tarsier genera inhabiting different island regions (Sulawesi, Borneo, and the Philippines). We examined adult individuals and collected 17 craniodental measurements on 153 tarsiers representing all three regions. We used principal component analyses (PCA) to describe multivariate allometry supplemented with discriminant function analysis (DFA) and k-means clustering to identify tarsier groups. Strong size and size-related patterns were found in the skull and dentition, with PC1 explaining 86% and 56% of the variation in these regions, respectively. Size-related shape changes were most pronounced in the skull base which scaled with strong negative allometry. Weaker positive allometry was found for upper first and second molar width, as well as upper third molar palate width. In addition, the size-related PC1 clearly separates tarsiers into two groups (Sulawesi v. Borneo/Philippines) which are confirmed by DFA and k-means clustering. Despite deep divergence times in the Miocene, living tarsiers are very much scaled craniodental variants of one another across a limited size range, which may reflect

developmental and biomechanical adaptations to filling their hyper-faunivorous niche.

### Households, Intensification and Well-being: James Wood and the Anthropology of Landscape

TIMOTHY M. MURTHA  
Landscape Architecture, Penn State

James Wood's contributions to demographic anthropology, especially those considering households, well-being, Malthus and Boserup, offer a transformative perspective on the long-term dynamics and interactions among households, land use and environmental change. This poster reflects on these contributions and specifically, his influence on landscape archaeology and anthropology. Through a discussion of population growth and decline, agricultural intensification and land use change, I review how this information and Wood's ideas have been used to inform traditional archaeological studies of settlement patterns and landscape change. His ideas have been applied to a number of archaeological and historical contexts; however, particular emphasis will be placed here on describing the coupled natural and human system dynamics that occurred between 1850 and 2000 in Orkney, Scotland. Using historical cadastral maps and traditional archaeological settlement pattern survey, I compare changing patterns of land use and land cover to historic population patterns in the five northern islands of Orkney: Westray, Sanday, Eday, North Ronaldsay and Papa Westray. Integrating considerations of well-being and household intensification transforms what traditionally would be a chronological comparison of regional population estimates and some measure of land cover change into an ethnographically informed and interwoven narrative of landscape history, households, people and place.

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### Yet another new cranium from the early Miocene: the most complete male cranial remains of the fossil ape *Ekembo*

SAMUEL MUTETI<sup>1,2</sup>, THOMAS LEHMANN<sup>3</sup>, LAUREN MICHEL<sup>4</sup>, SUSANNE COTE<sup>5</sup>, DANIEL J. PEPPE<sup>6</sup>, RUTGER JW. JANSMA<sup>1</sup> and KIERAN P. MCNULTY<sup>1</sup>

<sup>1</sup>Anthropology, University of Minnesota, <sup>2</sup>Earth Sciences, National Museums of Kenya, <sup>3</sup>Messel Research and Mammalogy, Senckenberg Research Institute and Natural History Museum, <sup>4</sup>Earth Sciences, Tennessee Technological University, <sup>5</sup>Anthropology and Archaeology, University of Calgary, <sup>6</sup>Geosciences, Baylor University

*Ekembo* fossils (previously referred to *Proconsul*) from Rusinga Island provide the best known sample for studying fossil ape paleobiology prior to the origin of crown hominoids. Morphology of the skull is particularly well documented in the

almost complete but distorted female specimen KNM-RU 7290. Sexual dimorphism in the facial skeleton is known primarily from the rostrum and palate. Here, we describe a new cranium discovered at locality R106 in Rusinga's Hiwegi Formation (ca. 18.08-18.3 Ma). This large specimen is the most complete male cranium found so far, preserving much of the facial region including a nearly complete right orbit, nasal aperture, and palate. Unlike many specimens from Rusinga, the new cranium exhibits almost no deformation; breaks across the anatomy are mostly sharp and provide unambiguous evidence of the connections between the upper and lower face. Half of the nuchal torus is also preserved but does not join with the rest of the specimen.

This cranium imparts important new information about variation within *Ekembo* in two key ways. First, it provides a test of the cranial features recently proposed to distinguish *E. nyanzae* from *E. heseloni*; the suite of diagnostic features pieced together from more fragmentary remains are borne out in this new specimen. Second, it gives us a much more complete picture of sexual dimorphism in the face of *Ekembo*, especially with regard to the upper face and its relationship to the mid- and lower face.

*This research was funded by the University of Minnesota and NSF grants to KPM.*

### When I Grow Up; Limb Development and Adaptation in Old World Primates

JASON A. NADELL, SARAH ELTON and KRIS KOVAROVIC  
Anthropology, Durham University

While primate limb morphology has been shown to closely reflect the mechanical loads they experience, their development is less understood. Here we investigate how the limb bones of five catarrhine taxa adapt their cross-sectional geometry over the course of ontogeny, and further, evaluate which sections more readily reveal signals of plasticity or canalization at discrete locations along them. The sample included male and female postcranial specimens from *Pan* (n = 48), *Gorilla* (n = 46), *Pongo* (n = 41), *Hylobates* (n = 45) and *Macaca* (n = 53). Because most primate genera undergo some form of locomotor transition as they mature, structure was evaluated across infant, juvenile, and adult subgroups. Three-dimensional models of the humerus, ulna, femur and tibia were generated using a NextEngine laser scanner and sectioned at the proximal (80% length), distal (20%) and midshaft sections along each diaphysis. Geometric properties proportional to shape and strength were then used to compare variation across limb segments for each taxon. Our results demonstrate that specific bone sections serve as strong indicators of locomotor behavior, while others appear more reflective of basal primate characters.

## ABSTRACTS

Strength and shape ratios at the tibial midshaft effectively discriminated between developmental and taxonomic groups, while sections like the distal ulna revealed no intra- or interspecific variation. Further, midshaft properties were often indistinguishable between infant taxa, going on to exhibit marked locomotor signals with maturity. These findings build on a growing body of developmental research, granting further insight into primate locomotor adaptation in extant and extinct taxa.

*We are grateful to the Wenner-Grenn Foundation (grant 9098), British Association for Biological Anthropology and Osteoarchaeology and the Royal Anthropological Institute for their generous financial assistance.*

### **Cementum ultrastructure, a comparative perspective from synchrotron x-ray scanning: fluorescence and diffraction**

STEPHAN NAJI<sup>1,2,3</sup>, WILLIAM RENDU<sup>2</sup>, LIONEL GOURICHON<sup>3</sup>, ZHONGHOU CAI<sup>4</sup> and STUART STOCK<sup>5</sup>

<sup>1</sup>Anthropology, New York University, <sup>2</sup>Anthropology, CNRS, NYU-CIRHUS, <sup>3</sup>Anthropology, Université Côte d'Azur-CNRS, CEPAM, <sup>4</sup>Advanced Photon Source, Argonne National Laboratory, <sup>5</sup>Cell & Molecular Biology, Northwestern University

Mammal teeth are composed of enamel, dentin, and cementum. All three have a comparable growing pattern of cyclic incremental deposits. While dentin and enamel have been extensively studied, cementum is still largely ignored. However, cementum grows throughout life, unlike dentin and enamel which both stop once the tooth is fully formed. Cementum function is to anchor the periodontal ligaments and maximize root stability within the alveolar bone. Cementum incremental growth layers are deposited in a biannual light-dark pattern when observed in thin sections using transmitted light microscopy. This pattern has been strongly correlated to age-at-death and season at death in multiple reference samples in over 72 mammal species, including human.

The nature and composition of these increments are still debated in the literature. This study investigates the structure of individual acellular increments using x-ray fluorescence mapping and x-ray diffraction mapping with microbeams of synchrotron radiation on four samples of reindeer, one bison, and one human.

Results show that throughout the cementum, peaks in calcium, phosphorous, and zinc fluorescent intensities matched the carbonated hydroxyapatite diffracted intensity and the maximum intensity of light annual growth increments observed optically in transmitted light.

Contrary to previous conclusions, the alternating light-dark pattern observed in acellular cementum in light microscopy does not come from differences in collagen fibers orientation.

These results suggest that changes in contrasts in optical light interpreted as seasonal annual growth increments are related to changes in carbonated hydroxyapatite content.

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### **A comparative and ontogenetic analysis of zygapophyseal facets along the thoracolumbar transition in apes and humans**

THIERRA K. NALLEY<sup>1</sup>, JACOB WOOD<sup>2</sup> and CAROL V. WARD<sup>3</sup>

<sup>1</sup>Department of Medical Anatomical Sciences, Western University of Health Sciences, <sup>2</sup>Department of Anthropology, Southern Illinois University, <sup>3</sup>Department of Pathology and Anatomical Sciences, Department of Anthropology, University of Missouri-Columbia

The thoracolumbar transition marks the shift from thoraciclike to lumbarlike vertebral facet morphologies. This transition is of interest because of its relevance to spinal mechanics during bipedality and because its placement in early hominins appears to differ from that of extant hominoids. The thoracolumbar transition is often defined using either facet orientation or curvature, or, more rarely, using both, leading to conflicting conclusions about the nature of the transition. The ontogeny of facet morphology is also poorly understood and has never been evaluated in apes. Our study evaluates zygapophyseal facet orientation and curvature throughout development in extant hominoids to identify potential phylogenetic and behavioral influences on vertebral morphology. We collected landmark data from photographs of vertebrae spanning the thoracolumbar transition (T9-L5) from individuals of *Homo*, *Pan*, *Gorilla* and *Pongo* (n = 147) partitioned into five developmental stages based on dental eruption. Procrustes and principal components analyses indicate that lumbar facet curvature increases during development for all hominoid genera and that adult morphology is generally reached by M1 eruption. Although there is overlap among groups in facet curvature and orientation, gorillas tend to have flatter facets than other taxa, especially across the thoracolumbar transition, and chimpanzees tend to have less sagittally rotated facets than other taxa, particularly at L1. Investigating both aspects of vertebral joint morphology aids in the development of more fine-grained understanding of the evolutionary and functional significance of the morphological transition from thoracic to lumbar regions of the vertebral column.

*The Leakey Foundation*

### **Prenatal crown formation time of human deciduous central incisors in a pre-industrial population**

ALESSIA NAVA<sup>1,2</sup>, PAOLA F. ROSSI<sup>2</sup> and LUCA BONDIOLI<sup>2</sup>

<sup>1</sup>Environmental and Evolutionary Biology, Sapienza University of Rome, Italy, <sup>2</sup>Section of Bioarchaeology, National Museum of Prehistory and Ethnography "Luigi Pigorini", Museum of Civilizations, Rome, Italy

Dental enamel, as individual biological archives of first infancy's developmental history, records at microscopic level physiological and rhythmical growth markers as well as pathological stresses that are capable to disrupt the formation of the mineralized tissues. Nonetheless, most of the studies have focused on the most readable post-natal portion of the enamel even though the analysis of the prenatal one is pivotal in understanding fetal growth, and allows retrieving information on the mother's health status during pregnancy.

This contribution reports new data describing the prenatal enamel of central deciduous incisors from the Imperial Roman necropolis of Velia (I-II century AC, Salerno, Italy) and from 4 modern exfoliated deciduous teeth. The archaeological sample consists of 18 teeth (12 upper and 6 lower incisors) free from incisal wear and showing exceptional visibility of the cross striations in the prenatal enamel. Histological sections were analyzed in order to collect data on prenatal crown formation times, daily secretion rates (DSR) and enamel extension rates (EER). Results for the Velia's sample allowed to derive a new regression formula, through a robust regression approach, that describes the average rates of deciduous enamel formation and to be used as a reference for pre-industrial populations.

Finally, for a selected subset of Velia's central incisors, we estimated the topographical distribution of the DSR, collecting random measurements (N>100) across the entire crown profile. The spatial distribution of the DSR was calculated from raw data using a surface fit obtained by thin plate regression splines.

### **Ace in the Hole: Investigating High Levels of Glenoid Fossa Pathologies in Comparative Samples from the Americas**

DEBORAH L. NEIDICH and SARAH A. JOLLY  
Anthropology, University of Pittsburgh

Two recent studies of diachronic prehistoric human skeletal samples from the United States (Tennessee) and Peru found high rates of a peculiar scapular defect on the glenoid fossa, which is not thought to be described elsewhere in the paleopathological literature. This pathology is exhibited as a small circular depression in the center of the glenoid fossa, with little to no porosity within the defect. It was observed in 49% (67/137) observable glenoid fossas of scapulae

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from the Tennessee sample and 18% (10/57) from the Peruvian sample. Differential diagnosis suggests that this bony defect is not universally associated with either degenerative changes on the glenoid body or corresponding humeral head pathologies. Therefore, this pattern is inconsistent with what is expected of degenerative joint disease (DJD), enthesopathies, osteochondritis dissecans, humeral impingement, or rotator cuff disease. This case study reviews paleopathological data in conjunction with anatomical and clinical literature to understand the cause and functional significance of these bony anomalies, while evaluating the possibility that this condition represents a scapular non-metric trait that has not been previously described.

### Ranging patterns and behaviour of Javan slow lorises in a dynamic agroforestry landscape in West Java

ANNA I. NEKARIS, STEPHANIE A. POINDEXTER, KATHLEEN D. REINHARDT, MARIE A. SIGAUD and VINCENT J. NIJMAN

Nocturnal Primate Research Group, Oxford Brookes University

In a world increasingly dominated by humans and their agricultural needs, understanding the ability of wildlife to survive in human-modified landscapes is vital. We studied the ability of Critically Endangered Javan slow lorises *Nycticebus javanicus* to survive in a landscape almost completely modified by humans in Cipaganti Java, Indonesia from 2011-2016. In 2011, chayote *Sechium edule* was not an important crop, but after its introduction in 2013 it gained popularity and by 2016 was economically the area's most important cash crop. Chayote requires bamboo frames for support, thereby potentially conflicting with the needs of slow lorises, which regularly sleep and feed in dense bamboo patches. In 2015 chayote frames, mostly constructed on open fields, covered 12% of our slow loris study area, occupying on average 3.0% (range 0.5 – 6.1%) of the home ranges of slow loris social pairs, which remained the same size (median 11-16 ha). Slow lorises are largely arboreal and they frequently used the frames to avoid open ground use in their respective ranges. Three sleep sites we monitored were unaffected by bamboo cutting, 24 disappeared altogether, and 201 continued to be used by the slow lorises and local people. The fast growth rates of bamboo, and the recognition of the value of bamboo by farmers, allow persistence of slow loris sleep sites. Overall the introduction of chayote and the need of bamboo frames did not result in conflict between farmers and the slow lorises, and once constructed the frames proved to be beneficial for the primates.

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### The On-line IMPACT Radiological Mummy Database: the quest for standardization in mummy studies

ANDREW J. NELSON<sup>1</sup> and ANDREW D. WADE<sup>2</sup>

<sup>1</sup>Anthropology, The University of Western Ontario,

<sup>2</sup>Anthropology, McMaster University

The on-line IMPACT radiological database (Nelson & Wade 2015) was developed to facilitate a shift in paleoradiological studies of mummies from case studies to synthetic studies with large sample sizes. This shift allows for a better appreciation of variability in mummification practices as well as patterns of health and disease in ancient populations.

Radiological studies are to a large extent standardized in terms of data format, based on the DICOM standard developed for the medical field. However, modes and methods of gathering and accessing and analyzing radiological studies are not standardized in any way. This issue makes it difficult to combine the results of multiple studies, which would extend the shift to larger and more synthetic studies referred to above.

Challenges to this standardization are many, but the key issue is that people analyze mummies for many different reasons, the two most basic of which are paleopathological studies and cultural practice of mummification studies. Furthermore, while it would be fairly easy to standardize the capture of CT scans of Dynastic period Egyptian mummies, for a mummification study, for example, other mummies, such as flexed Pre-Dynastic Egyptian or Andean mummies require different techniques of positioning and image acquisition.

Our recommendations are 1) to develop position-specific standards for the initial capture of radiological studies of mummies and 2) to develop standards of reporting of any analysis, such that the goals, methods and standards followed are clear, making sure that any subsequent researcher can assess the potential for cross-sample comparisons.

SSHRC/NEH Digging Into Data Challenge Grant

### Alterity and Anthropometrics: Blackness, Vulnerability, and Post-Colonial Identities in Biological Anthropology

ROBIN G. NELSON

Anthropology, Santa Clara University

*Alterity*, the state of being outside of, or a stranger to a particular space or cultural orientation, is imbedded within the ethos of our discipline. From its inception, Anthropology has investigated the

other, necessitating that researchers travel to distant field sites for data collection, analysis, and collaboration. Because scholars of color are a minority within the discipline, *alterity* speaks not only to disciplinary discourses about our study participants, but to the negotiations that scholars of color navigate in both our home institutions and our research locales. There is, thus, a constant work to be done substantiating oneself as an expert to study participants and colleagues – both of whom may be resistant to accepting one's professional status within their particular contexts. In this paper, I explore how the intersections of (1) Caribbean colonial histories and post-colonial present(s), (2) theoretical and methodological traditions in biological anthropology, and (3) unethical medical practices in communities of color have created a specific set of challenges regarding trust and intellectual authority for scholars of color. While my Blackness others me within the discipline, it has also provided access and insight into the enduring oppression that shapes everyday resistance and survival strategies in my study communities. Using original data from the Caribbean as the situational frame, I will provide an evidence-based examination of my methodological choices and topics of study, exploring how they have been shaped by a negotiation of DuBois' double consciousness, when those observing me are both the study participants and my intellectual peers.

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### Integration Between the Lower Face and the Dentition throughout Ontogeny

ALLISON NESBITT

Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University

The dentition and lower face have similar developmental origins, functions, and the teeth develop in the maxillary bone, which makes it likely that the face and teeth develop in a coordinated manner throughout the growth and development of an organism. This study examines the pattern and magnitude of morphological integration between the face and dentition in *Pan troglodytes* and *Homo sapiens* to test whether specific ontogenetic changes in facial morphology are associated with particular dental development events, such as the formation or eruption of the permanent molars. The immature and adult human and chimpanzee cranial sample (n=240) was divided into five dental stages according to the development of the deciduous and permanent dentition. Geometric morphometric analyses of 3D cranial and dental landmarks were used to evaluate shape covariation. I used partial least squares analyses to assess the pattern of covariation between the

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face and the teeth. In addition, the covariance ratio and RV coefficient were utilized within each species to quantify the magnitude of covariation between the dentition and face in each dental stage and to evaluate if the magnitude of covariation decreases throughout ontogeny. Results of the pattern of covariation between the face and the teeth indicate chimpanzees and humans with wider palates, and less prognathic faces, have larger molars and smaller anterior teeth. The relative magnitude of covariation was similar between species and varied between several dental stages within species. These results may provide insights into the evolution of the orthognathic faces of modern humans.

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### The Evolution of Modern Human Endocranial Shape

SIMON NEUBAUER, PHILIPP GUNZ and JEAN-JACQUES HUBLIN

Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Modern humans have evolved large and globular brains while other large brained human species like Neanderthals did not have globular endocrasts. Key to this difference is neurocranial globularization that develops in the first year of life in modern humans. It remains unknown, however, how and when during the evolutionary history of our species this developmental pattern emerged. Here, we analyze endocrasts of modern humans from different geologic time periods and investigate whether globularity evolved rapidly at the origin of our species or gradually within *Homo sapiens*.

To this end, we used computed tomography scans of fossil *Homo sapiens* (N=14), Neanderthals (N=9), *Homo erectus* (N=8) and recent modern humans (N=99). For partially complete fossils, we first realigned fragments, estimated missing regions and corrected for taphonomic deformation based on the digital data. Then we generated virtual endocrasts and obtained 935 endocranial landmarks and sliding semilandmarks on curves and the surface for geometric morphometric analyses.

Our results demonstrate that recent modern humans, *Homo erectus* and Neanderthals form distinct clusters in shape space. Upper Paleolithic and Mesolithic individuals fall within recent modern human variation. However, earlier *Homo sapiens* individuals differ from the three main clusters. Overall, fossil modern humans diverge from the archaic evolutionary trajectory and follow a temporal trend towards recent human variation. The characteristic modern human endocranial shape was not established

at the origin of our species and gradual evolutionary changes within the *Homo sapiens* lineage contributed to the typical globular brain shape of recent humans.

This research was funded by the Max Planck Society.

### A Comparative Study of the Effects of River Flow Rate on Decomposition

MADDISEN NEUMAN

Geography and Anthropology, Louisiana State University

While the general biological processes of decomposition are known to forensic anthropologists, data on aquatic decomposition is in need of refinement. Water composition varies in mineral content, temperature, flow rate, and scavengers; each of these elements can have an effect on the rate of decomposition. This study specifically focuses on the effect of river flow rate on decomposition by comparing the rate of decay of a feral pig (*Sus scrofa*) on land (control specimen), in faster flowing water, and in slower flowing water. The hypothesis states that the pig placed in the faster section of the river will decompose more quickly due to increased water flow velocity.

Three feral pigs weighing ~100 pounds were deposited at their respective research sites on the Amite River in Galvez, Louisiana. Each pig was protected from large scavengers by a thick wire cage equipped with a water temperature data logger. The river subjects were secured to the bank by an industrial chain kept afloat by boat bumpers.

Daily visits to the site revealed that the control pig was skeletonized in two weeks and both water pigs were reduced to a few bones in just over three weeks. Maggot activity and the presence of fish differed between the two water specimens, but they decomposed at similar rates. The hypothesis was rejected as river flow rate did not seem to impact the decomposition rates of the pigs. This study indicates that each environment is distinct and caution must be taken when managing aquatic forensic cases.

### Uncoupling Protein 1 (UCP1) and Selection in Warm and Cold Climates

LISA NEVELL

Department of Sociology and Anthropology, Illinois State University

*Uncoupling Protein 1 (UCP1)* encodes a protein which plays an essential role in non-shivering thermogenesis (NST). NST generates heat through metabolic processes in response to cold stress. NST is believed to be the principal function of *UCP1*. This paper tests the hypothesis that the direction and intensity of selection acting on *UCP1* will differ based on the mean temperature of study populations. Sequence data for human polymorphisms in the coding region +/- 1000bp

of *UCP1* were obtained from Hapmap phase3.2\_nrb36 from several populations, e.g. Americans of African Ancestry living in the American Southwestern states (ASW) and Americans of Northern European Ancestry living in Utah (CEU). These two populations share many aspects of behavior including housing, exercise, and diet. A Tajiman's D statistic was calculated using DNAsp software. The ASW sample has a Tajiman's D score of 2.41, where the CEU sample has a score of 3.23. Both the warm climate and cold climate groups show positive selection in *UCP1*, however the intensity of selection is relaxed in the warm climate group. These preliminary data are consistent with the hypothesis that *UCP1* is adaptively evolving in modern human populations and that positive selection in *UCP1* is more intense in populations exposed to colder temperatures.

### Aliphatic esters in primate-consumed fruits: a reliable cue for fruit quality?

OMER NEVO<sup>1</sup> and KIM VALENTA<sup>2</sup>

<sup>1</sup>Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, <sup>2</sup>Department of Anthropology, McGill University

Non-human primates are now known to possess high olfactory capacities which can provide useful information in the process of food acquisition. Yet while primates have been documented to be able to locate and identify desired food items using their sense of smell, data documenting which chemical substances they use are scarce, mainly because the chemical composition of odors of primate foods has remained practically unknown. Esters are a product of a reaction between alcohols and acids – both often derive from microbial activity. As a result, the concentration of different esters in fruit odor may be a reliable cue for ripeness and sugar content. Moreover, non-human primates of several lineages have been shown to possess high olfactory sensitivity and discrimination capacity of aliphatic esters. As a result, perception of esters may be a prime function of the primate sense of smell in the context of food acquisition. Here, we provide the largest characterization to date of the odors of ripe fleshy fruits consumed by wild primates in two systems: Madagascar and Uganda. We show that esters are among the most common compounds in odors of ripe fruits. This indicates that the high olfactory sensitivity that primates have for detecting esters may be useful for identification of ripe fruits in the wild, and might have even been selected for this purpose.

### Life in the shadows: the impact of social status, geographic location, and vitamin D deficiency on child health in 18th-19th century England

SOPHIE L. NEWMAN

Department of Archaeology, Durham University

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Rickets is a condition that occurs in children due to deficiencies in vitamin D. This arises principally from insufficient sunlight exposure, leading to severe bending deformities, and impairment of the immune system. The highly polluted urban environment, combined with a multitude of adverse social factors, led to a dramatic increase in its prevalence during the 18<sup>th</sup>-19<sup>th</sup> centuries, with bending deformities often described by social commentators of the time concerned with the welfare of the working classes.

Using palaeopathological data (metabolic disease, non-specific infection, cribra orbitalia, and dental enamel hypoplasia) the geographical and social impact on susceptibility to vitamin D deficiency and further health stressors was assessed in 575 non-adults (0-17 yrs) from six urban sites (c. AD 1711-1856) from the North and South of England.

The prevalence of vitamin D deficiency was consistently high amongst the four London-based sites from the south, regardless of social status. Therefore, rickets was not just a disease of the poor, revealing a wealth of information regarding child-care practices across the social strata. However, an elevated prevalence of rickets seen within the northern population of Coach Lane, North Shields is perhaps indicative of a regional specific risk of vitamin D deficiency. This may be related to latitude, and/or the influence of differing industries in operation in the North-East. Sites with a particularly high rate of metabolic disease in general, often exhibited higher rates of other indicators of stress, revealing the impact of metabolic disease on overall health and immune resistance in children at this time.

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### Countering infanticide: chimpanzee mothers are sensitive to the relative risks posed by males on differing rank trajectories

NICHOLAS E. NEWTON-FISHER and ADRIANA LOWE

School of Anthropology & Conservation, University of Kent

Infanticide by males is common in mammals. According to the sexually-selected infanticide hypothesis, risks increase when males can kill unrelated infants, and when an infanticidal male's chance of siring the replacement infant is high. Infanticide occurs in chimpanzees (*Pan troglodytes*), and rank predicts paternity, so infanticidal low-ranking males are unlikely to kill their own offspring while males who rise in rank are more likely to father potential future infants than any existing ones. Given that mothers should be selected to reduce infanticide risk, we predicted that they would attempt to adjust the exposure of their infants to potentially-infanticidal males:

specifically, that they would reduce association with low-ranking and rank-rising males. We examined data on female association patterns collected from the Budongo Forest, Uganda, during a period encompassing both relative stability in the male hierarchy and a period of instability with a mid-ranking male rising rapidly in rank. Using linear mixed models, we found that mothers reduced their association with mid-low ranking males, and particularly with the rank-rising male, contingent on infant age, during the period of instability. Our results support the sexually-selected hypothesis for infanticide, and demonstrate that female chimpanzees are sensitive to the relative risks posed by adult males.

### An investigation of the relationship between maxillary sinus volume and midfacial growth using a pig model

CHRISTINA L. NICHOLAS<sup>1</sup>, NATHAN E. HOLTON<sup>2,3</sup>, BETHANY DOOLITTLE<sup>2</sup> and THOMAS SOUTHWARD<sup>2</sup>

<sup>1</sup>Orthodontics, University of Illinois at Chicago,

<sup>2</sup>Orthodontics, University of Iowa, <sup>3</sup>Anthropology, University of Iowa

In humans, the maxillary sinuses have been argued to potentially be an 'accommodative' zone, responding to changes in the shape of the midface and nasal cavity through growth. However, the actual developmental relationship between these structures remains poorly defined. In this study, we assess how experimentally-induced changes in midfacial growth in *Sus scrofa* (pig) affect maxillary sinus volume. Experimental pigs had their circummaxillary sutures surgically plated at 2 months of age, preventing further growth at this site. CT scans of the pigs at 6 months were used to collect unilateral maxillary sinus volumes and a series of 3D coordinate landmarks across the cranium. We ran statistical tests on this data, including a univariate comparison of sinus volume between the experiment (n=10) and control/sham (n=18) groups; a regression of sinus volume on centroid size; and a multivariate regression of shape on sinus volume. The experimental pigs exhibited an approximately 35% reduction in maxillary sinus volume compared to the control/sham pigs. Sinus volume was statistically significantly correlated with centroid size ( $p=0.001$ ;  $r^2=35.6\%$ ). Lastly, sinus volume was correlated with craniofacial shape ( $p=0.001$ ;  $r^2=26.95\%$ ); smaller sinuses were associated with a relative shortening of the facial skeleton and maxillary retraction. These results indicate that, at least in pigs, anterior facial growth is an important factor in maxillary sinus growth. They also lend support to the hypothesis that maxillary sinus morphology is a secondary result of growth in the other structures of the midface. Future work will investigate changes in maxillary sinus shape in this sample.

### Anthropology education in the age of NAGPRA: Where we stand and where we might go

APRIL K. SIEVERT and TERESA NICHOLS

Glenn Black Lab of Archaeology, Indiana University

The Native American Graves Protection and Repatriation Act (NAGPRA) was signed into law in 1990, but over twenty-five years later debate remains among anthropologists about who needs to be taught about NAGPRA and why. In 2014 and 2015, the Learning NAGPRA project received NSF funding to study the current state of NAGPRA teaching and training and to work collaboratively with tribal cultural experts, educators, cultural resource management archaeologists, and students to develop educational materials. Research data has been collected through interviews, online surveys sent to university educators and students, an analysis of course syllabi and textbooks, and a comparative teaching study at five schools to better understand NAGPRA education. This research data has been used to inform the discussions of the 2015 and 2016 Learning NAGPRA Collegium workshops, held at Indiana University Bloomington, and the formation of four working groups developing different educational materials. After reviewing our major research findings and the objectives of our working groups, we conclude that teaching about NAGPRA presents valuable opportunities to address such fundamental issues as forming research questions, the stages of research design, the steps of the consultation process, and the benefits of collaboration for developing innovative research questions and methodologies.

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### Analysis of Mexican American full genome DNA sequences identifies 137 SNPs of unique Native American origin

SARA D. NIEDEBLSKI and JEFFREY C. LONG

Anthropology, University of New Mexico

The goal of this study was to discover genetic variants that are common in Native Americans but absent in other continental populations. Such variants will shed light on the evolutionary history of Native Americans and they may provide insight into distinctive patterns in Native American health. To achieve our goal, we queried the Thousand Genomes Project (TGP) dataset for single nucleotide polymorphism (SNPs). This project provides whole genome DNA sequences for N=2,577 individuals that belong to 26 populations. The DNA sequences were produced using next-generation methods with 50X coverage. Although TGP sample does not include un-admixed Native Americans, many Native American genomes are represented in the TGP Mexican American sample (N=69). Roughly 50% of Mexican American ancestors were Native American. We labeled Native American Specific alleles as those with

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a frequency above 0.15 in Mexican Americans and below 0.01 in all other non-American populations. The 0.15 threshold implies a frequency above 0.30 in Native Americans and implies that 50% of Native Americans would carry the allele. We found 137 SNPs that met our criterion. This is enigmatically low. Elsewhere, we found 25,209 SNPs specific to indigenous Africans and 2,253 specific to non-Africans. 137 SNPs is far fewer than predictions from coalescent simulations that accurately predict the observations in all other global regions. Furthermore, none of the American alleles identified suggest any functional link to Native American disease disparity. These findings are noteworthy in that they challenge commonly cited predictions for the health and genetic structure of Native American people.

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### Migration, admixture and genetic continuity in pre and post-contact Puerto Rico

MARIA A. NIEVES-COLON<sup>1</sup>, WILLIAM J. PESTLE<sup>2</sup>, JADA BENN-TORRES<sup>3</sup> and ANNE C. STONE<sup>1</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Anthropology, University of Miami, <sup>3</sup>Department of Anthropology, Vanderbilt University

Native American groups exclusively occupied the Caribbean island of Puerto Rico since 4,000 years before present, until European colonization in 1493. Due to the demographic shifts that occurred after contact, the origins of these ancient populations and their contributions to the ancestry of modern Puerto Ricans are still disputed. Further, although there is archaeological evidence of continuous interaction between ancient Puerto Rican groups and other Caribbean communities, the role of genetic exchange in maintaining these social networks is currently unknown. Here we use ancient DNA (aDNA) to characterize patterns of migration and genetic admixture in pre-contact Puerto Rico, and to examine the extent of genetic continuity between ancient groups and modern Puerto Ricans. We used in-solution capture and next-generation sequencing to obtain ancient DNA from 46 human skeletal remains (dated between A.D. 500–1300), from three archaeological sites: Tibes, Paso del Indio and Punta Candeleró. Preliminary data from 16 complete mitochondrial genomes (mean read depth: 9.8x) find high proportions of haplogroups A and C in this sample (43% each). This distribution, as well as the haplotypes represented, is suggestive of some continuity between pre-contact populations and modern Puerto Ricans of Native American mitochondrial ancestry. However, very few mitochondrial lineages are shared between coeval pre-contact island populations, suggesting that female-mediated gene flow was not essential to Pan-Caribbean social interaction. Nuclear genotypes currently being generated from our ancient sample will further inform these issues and also

provide insight into the links between pre-contact Puerto Rican groups and continental indigenous populations.

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### DNA barcodes and the identification of extant and extinct primates

VINCENT NIJMAN<sup>1</sup> and TIM ROBBINS<sup>2</sup>

<sup>1</sup>Anthropology and Geography, Oxford Brookes University, <sup>2</sup>Life Sciences, Oxford Brookes University

For comparative primatology accurate recognition of basal taxa is essential. The mitochondrial cytochrome oxidase subunit 1 (*cox1*) gene has been selected as a near-universal marker in animals, due to its high phylogenetic resolution with marked differences in intra- and interspecific genetic variation. Early attempts to test the suitability of *cox1* as a diagnostic marker for primates suffered from a low phylogenetic resolution (few species with a bias towards Old World Monkeys and humans), lack of sequences (with the majority of species being represented by single sequences), and absence of extinct taxa. We downloaded all extant and extinct primate *cox1* sequences from two different repositories and tested their suitability in species identification. The 699 sequences represented 105 extant and 4 extinct species of 47 genera, with 12 genera represented by three or more nominal species. While distantly-related species can be unequivocally identified challenges arise when comparing species within genera (e.g. *Homo*, *Hylobates*, *Papio*) or when comparing genera that have seen significant taxonomic revisions in recent years (e.g. *Aotus*, *Cebus-Sapajus*). Overall the rate of correctly identifying species was low compared to other animal taxa which suggests (1) misidentification or mislabelling of species within repositories, (2) extensive hybridisations between taxa, or (3) a liberal approach of recognizing individual species by primatologist.

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### Whole Mitochondrial Genomes Reveal the Maternal Origin of the Bronze Age Xiabandi Population in Xinjiang, Northwest China

CHAO NING and YINQIU CUI

School of Life Sciences, Jilin University

Xinjiang is geographically located in Central Asia, and it has played an important role in connecting eastern Eurasian and western Eurasian, has been a focal place for gene and cultural exchanges. Despite studies on Archaeology, Physical Anthropology and ancient DNA had revealed a West-East admixed population of the Bronze

and the Iron Age in this region, when and how this admixture started, especially with regard to the origins and dynamics of the Western specific component remain unclear. Here we sequence 17 complete mtDNA sequences from the Bronze Age Xiabandi cemetery, located in the westernmost part of Xinjiang. We then compare this 'real-time' genetic data with a large dataset of ancient and modern Mitogenomes available. Our results allow a higher resolution on maternal heritage of ancient Xinjiang population, and indicate that all the sequenced mitochondrial genomes of Xiabandi population was derived from the Western Eurasia. We suggest that Proto-Xiabandi people could have migrated from somewhere of Pontic steppe ~4200 ybp, and during their way to Xiabandi, they gained genetic contributions from Central Asia. This pattern is consistent with the hypothesized spread of Indo-European populations and more possibly with the expansion of Indo-Iranian populations.

### Functional morphology of the occipital condyles in anthropoids

ABIGAIL C. NISHIMURA<sup>1</sup>, PETER J. FERNÁNDEZ<sup>2</sup>, JORDAN S. GUERRA<sup>3</sup> and GABRIELLE A. RUSSO<sup>3</sup>

<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, <sup>2</sup>Department of Anatomical Sciences, Stony Brook University, <sup>3</sup>Department of Anthropology, Stony Brook University

Because the skull's occipital condyles articulate directly with the first cervical vertebra of the neck, occipital condylar morphology might be informative with respect to head position during postural and locomotor behaviors. Here, we examine the relationship between occipital condylar morphology and metrics of neck posture, trunk posture, and locomotor mode using three-dimensional geometric morphometrics. Using a sample of extant anthropoids (N = 25 species), we collected, digitized, and superimposed condylar landmark data using a MicroScribe digitizer and standard Procrustes analyses. Differences among postural and locomotor groups were analyzed using a phylogenetically-informed Procrustes ANOVA, followed by permutation tests to evaluate hypotheses about shape changes. Geometrically-derived metrics (condylar curvature, location of the widest point, and base shape) were analyzed using phylogenetic multivariate multiple regressions. Results reveal differences in global shape among locomotor and postural groups. Habitual bipeds (i.e., *Homo sapiens*) have shorter, flatter condyles than other locomotor groups. Suspensory primates have mediolaterally wider condyles than all quadrupeds. Within quadrupeds, arboreal species have more inferiorly-facing condyles, while terrestrial species have more laterally-facing condyles. Species that have orthograde-adapted trunks exhibit mediolaterally wider condyles than

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species that have pronograde-adapted trunks. With regard to geometrically-derived metrics, species with more orthograde neck postures have less anteroposteriorly curved condyles than species with more pronograde neck postures, but this trend is driven by *H. sapiens*. This study provides evidence of functional adaptations to posture and locomotion in anthropoid occipital condyles, with potential applications for extinct hominin analyses.

Funding support was provided by The Leakey Foundation.

### Isotopic Variability of Chimpanzee Vertebrate and Invertebrate Prey at Gombe National Park

REBECCA S. NOCKERTS<sup>1</sup>, ROBERT C. O'MALLEY<sup>2,3</sup>, MICHAEL L. WILSON<sup>1</sup> and DAVID L. FOX<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of Minnesota, <sup>2</sup>Department of Anthropology, The George Washington University, <sup>3</sup>Nutrition Laboratory, Smithsonian Institution, National Zoological Park, <sup>4</sup>Department of Earth Sciences, University of Minnesota

Meat constitutes a major part of the diet of human hunter-gatherers, and a significant part of the diet of many chimpanzee populations. Stable isotope analysis provides an important tool for reconstructing the proportion of meat eating in different modern and archaeological populations. However, such estimates are potentially confounded by the consumption of invertebrates. As a first step in examining this issue with the Gombe chimpanzee population we analyzed both their vertebrate and invertebrate prey. Our preliminary sample set includes their common vertebrate prey red colobus and bushbuck (n=3), as well as four categories of chimpanzee insect prey including bees, ants, termites, and caterpillars (n = 28).

Our results show that  $\delta^{15}\text{N}$  in these taxa varies from -1.60‰ to 10.80‰. Much of this variation is due to the different trophic levels of the prey types, from detritivores (termites, mean = 1.21‰) and herbivores (both vertebrate prey, mean = 4.58‰) to insectivores (driver ants, mean = 8.24‰). Researchers should be aware of this trophic effect when reconstructing the proportion of meat in the diet. Insect consumption can be a significant source of protein with  $\delta^{15}\text{N}$  values that combined can approximate the moderately high  $\delta^{15}\text{N}$  of herbivorous vertebrates. This effect is particularly important when examining sex differences in meat consumption, as female chimpanzees spend more time foraging for and consuming invertebrate prey than males. This difference in meat consumption is more pronounced in chimpanzees than humans, and should be considered when reconstructing periods of increased faunivory in short-turnover tissues like hair and feces.

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### Can acupuncture decrease stress and increase telomerase activity to promote healthy cellular aging among older adults with depression or anxiety?

AMY L. NON<sup>1</sup>, ELIZABETH S. CLAUSING<sup>1</sup>, LAURA S. REDWINE<sup>2</sup> and NIKKI C. RODNEY<sup>3</sup>

<sup>1</sup>Anthropology, UCSD, <sup>2</sup>Psychiatry, UCSD, <sup>3</sup>Anthropology, University of Florida

Older adults with depression and anxiety are at risk for increased morbidity and mortality, and accelerated cellular aging may play a role. Pharmacological treatments for these mood disorders are not always effective, and can be difficult for older adults due to unwanted side effects. Some evidence suggests that acupuncture, a form of alternative medicine, can alleviate depression and anxiety with few reported side effects, though it is unclear whether these findings extend to older adults. We hypothesized that an intensive period of acupuncture could decrease symptoms in older adults, and have a role in reducing cellular aging. In our collaborative study, we examined the effects of acupuncture on stress and well-being, and will ultimately examine telomerase activity. We recruited 32 older adults (mean age 61, 75% women, 97% white) in San Diego, CA. Participants received acupuncture treatments customized to their symptoms 3x/week for 2 months. Psychological data and peripheral blood were collected at baseline, after 2-months without acupuncture, and after 2 months of acupuncture. Longitudinal models adjusted for age and gender showed significant decreases after acupuncture in symptoms of anxiety (B=-4.7, SE=0.80, p<0.0001), depression (B=-4.2, SE=0.75, p<0.0001), perceived stress (B=-7.1, SE=1.3, p<0.0001), and an increase in perceived well-being (B=11.5, SE=3.2, P=0.0008), relative to baseline measures. These results indicate that a relatively short but intensive period of acupuncture can effectively enhance psychological well-being, and may have the potential to decrease cellular aging by increasing telomerase activity in older adults.

Funding was provided by a UCSD Center for Healthy Aging Pilot Award.

### Pigmentation variation in the presence of strong UVR: genetic and phenotypic variation in Island Melanesia

HEATHER L. NORTON<sup>1</sup>, LAUREN BOWSER<sup>1</sup> and JONATHAN S. FRIEDLAENDER<sup>2</sup>

<sup>1</sup>Anthropology, University of Cincinnati, <sup>2</sup>Anthropology, Temple University

Global patterns of human skin pigmentation are inversely correlated with the intensity of

ultra-violet radiation (UVR), suggesting variation in this phenotype has been strongly influenced by natural selection. In particular, purifying selection is expected to constrain skin pigmentation in high-UVR regions. However, in Island Melanesia phenotypic variation as well as genetic diversity in and around pigmentation candidate loci suggest a more complex picture. While pigmentation surveyed in 1136 individuals from the Bismarck Archipelago and Bougainville was relatively dark (mean skin M index = 73.2), it also exhibited a wide range of variation, with much of that variation explained by differences between islands (F=222.23, df=5, p < 0.0001) rather than by differences in UVR intensity in the region (F=0.70, df=1, p = 0.4491). Contrary to expectations, DNA sequence data collected from a subset of this sample (n=188) did not support a model of strong purifying selection acting on the pigmentation gene *MC1R* (p = 0.275), suggesting that variation has not been constrained by selection. Finally, 12 SNPs from 10 pigmentation loci known to influence pigmentation in other populations were genotyped in a subset of the phenotyped sample (n=225). Of the 8 SNPs that were polymorphic, none were significantly associated with skin pigmentation after Bonferroni correction. While this may be attributable to the relatively small sample size here, other factors, including population history/structure, European-specific ascertainment bias in SNP discovery, and epistatic interaction among loci may contribute to the complex phenotypic and genetic architecture of pigmentation in this region.

This work was funded by the Taft Research Center at the University of Cincinnati.

### Exploring artificial cranial deformation in a 5<sup>th</sup> century Germanic population from Croatia using multiple lines of inquiry

MARIO NOVAK<sup>1</sup>, KENDRA A. SIRAK<sup>2</sup>, DANIEL M. FERNANDES<sup>3</sup>, JOSIP BURMAZ<sup>4</sup>, MISLAV ČAVKA<sup>5</sup>, RACHEL HOWCROFT<sup>3</sup> and RON PINHASI<sup>3</sup>

<sup>1</sup>-, Institute for Anthropological Research, <sup>2</sup>Department of Anthropology, Emory University, <sup>3</sup>School of Archaeology, University College Dublin, <sup>4</sup>, Kaducej d.o.o., <sup>5</sup>University Department of Diagnostic and Interventional Radiology, University Hospital Dubrava

This project uses multiple lines of inquiry to analyse the remains of three individuals dated to the Great Migration period (5<sup>th</sup> c. CE) from Osijek in eastern Croatia. Based on archaeological context and radiocarbon dates, all individuals belonged to Germanic tribes, either Gepids or Ostrogoths. Little is known about these populations, although they played an important role during the final days of the Roman Empire.

The skeletal remains belonged to three adolescents between 12 and 16 years old, two of whom exhibited intentional artificial cranial deformation. Interestingly, a comprehensive bioarchaeological

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analysis and CT imaging suggest the use of two different types of artificial deformation: the circular erect and tabular oblique type. While this phenomenon has been observed in various ancient populations, its origins and purpose are still not fully understood.

Stable isotopes analysis (carbon and nitrogen) was performed on these two individuals. Both had high  $\delta^{13}\text{C}$  values (-17.0‰ and -15.5‰) and very similar  $\delta^{15}\text{N}$  values (9.5‰ and 9.9‰) suggesting a mixed terrestrial C3/C4 diet with a heavy reliance on resources such as millet.

Results from ancient DNA analysis (still pending) will indicate molecular sex, mitochondrial haplogroup, and allelic state at ancestry informative markers, enabling us to explore the genetic background of these individuals with high resolution molecular analyses.

The results of this study will provide new information on lifestyle and biological characteristics of Germanic populations inhabiting the Pannonian Basin during the 5<sup>th</sup> century, and will shed new light on the phenomenon of artificial cranial deformation in Europe.

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### Differential Diagnosis of a Possible Endocrine Disorder in an Ancient Maya Skeleton from the Chan Site, Belize

ANNA NOVOTNY and SAMANTHA MITCHELL  
Sociology, Anthropology, and Social Work, Texas Tech University

At the ancient Maya site of Chan, located in northwest Belize, a skeleton dating to the Late Preclassic period (400 BC-AD 250) was recovered from ceremonial architecture in the site center. The skeletal material was lightweight, porous, and brittle even though the skeletal elements were generally well preserved. The individual was a young adult male with perimortem fractures to ribs ten, eleven, and twelve, the twelfth thoracic and first lumbar vertebrae. A systemic infection was evident on the anterior aspect of the ribs as well as on the diaphysis of several long bones. We hypothesize that the fractures and infection were secondary to a disease process that caused the bones to become brittle and fragile. It is likely that the disease process was one that compromised bone strength, such as an endocrine or metabolic disruption that affected the entire skeletal system. This paper presents a differential diagnosis of possible causes. We compare the ancient remains macroscopically and microscopically (histology, micro-computed tomography) to modern clinical as well as archaeological examples of common endocrine disorders. The young age at death and fracture pattern suggest that a tumor resulting in hyperparathyroidism may have been the cause of the bone loss that led to the fracture and subsequent infection.

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### Intra-tooth Isotopic Variation and Implications for Reconstructing Seasonal Diet and Mobility in Ancient Nomadic Populations

SELIN E. NUGENT  
Department of Anthropology, The Ohio State University

How do nomadic populations engage in mobility, move within the landscape, and adapt their diets throughout the year? These are critical considerations of the lifeways and subsistence patterns of nomadic people, yet the ephemeral nature of nomadic habitation makes these details nearly invisible in archaeological contexts. This paper approaches these questions through biogeochemical methods on archaeological human skeletal remains by investigating patterns of intra-individual strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ), oxygen ( $\delta^{18}\text{O}$ ), and carbon ( $\delta^{13}\text{C}$ ) isotopic variation to identify chronological transhumance and dietary change in semi-nomadic pastoralists of the Middle Bronze Age (2400-1500 B.C.) Aras River Valley in Naxçivan, Azerbaijan. In order to investigate chronological isotopic variation, this research employs a sampling strategy adapted from faunal intratooth sampling approaches used to identify individual mobility and diet in zooarchaeological populations. A longitudinal series of human dental enamel samples corresponding to 3-4 months of dental enamel mineralization were collected along the third molar of each adult individual. Values are compared to measured environmental isotopic bioavailability in local water and plant resources, allowing for the estimation of seasonal highland-lowland transhumance, horizontal mobility across geological zones, and diet changes for each individual. Resulting intra-tooth isotopic heterogeneity suggests seasonal highland-lowland mobility and diversity in plants consumed throughout the year.

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### Genetic Diversity in the Dominican Republic: Implications for the Population and Demographic History of Hispaniola

ELIZABETH R. OAKLEY<sup>1</sup>, ROBERT PAULINO-RAMIREZ<sup>2,3</sup>, BERNARDO VEGA<sup>4</sup>, MIGUEL G. VILAR<sup>5</sup>, AIDA MENCIA-RIPLEY<sup>3</sup>, SUZANA GUERRERO-MARTINEZ<sup>2,3</sup>, ARISMENDY BENITEZ<sup>2,3</sup> and THEODORE G. SCHURR<sup>1</sup>

<sup>1</sup>Anthropology, University of Pennsylvania, <sup>2</sup>School of Medicine, Universidad Iberoamericana (UNIBE), <sup>3</sup>Research Department, Universidad Iberoamericana (UNIBE), <sup>4</sup>Office of the President, Dominican Academy of History, <sup>5</sup>Science and Exploration, National Geographic Society

The island nations of the Caribbean have been the site of complex human population movements that involve indigenous founders,

European colonizers, and enslaved African laborers. This multi-faceted settlement history creates specific patterns of genetic diversity that have been revealed by mitochondrial haplotype studies in island nations such as Cuba, Jamaica, St. Vincent, and Trinidad. However, coverage of other island nations is required to better understand human migration in the Caribbean. To expand our knowledge of Caribbean migration history and clarify the demographic history of the Dominican Republic, we analyzed genetic diversity in 1000 individuals from 25 different locations in the country. We sequenced the mtDNA control region for all individuals, and genotyped all male samples for Y-STR and Y-SNP variation. Our results showed that the maternal lineages of Dominicans were largely African in origin, with the remainder being Native American and West Eurasian. By contrast, their paternal lineages were largely West Eurasian, with Native American, African and South-East Asian lineages comprising the rest. These results reflect the strong influence of non-native admixture, particularly European male contributions, on the genetic diversity in the Dominican Republic. The relative frequencies of these maternal and paternal lineages also varied among the 25 communities, revealing local patterns of diversity related to the settlement history of and recent demographic movements in the country. We further noted great mtDNA and Y-chromosome haplotypic diversity in Dominican populations. Overall, this study will provide new insights into the history and structure of genetic diversity in the Dominican Republic.

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### Examining Social Stress through Self-Directed Behavior in Wild Orangutans

CAITLIN A. O'CONNELL and CHERYL D. KNOTT  
Anthropology, Boston University

Orangutans are considered semi-solitary and highly constrained by poor fruit availability in their Southeast Asian forest habitat. As such, we hypothesized that meeting conspecifics would elicit psychosocial stress in a wild population in Gunung Palung National Park on the island of Borneo. Self-directed behavior has been identified as a behavioral marker of anxiety in non-human primates. During day-long focal follows, all instances of yawning, self-scratching, and self-grooming were recorded during 10-minute intervals of unobstructed orangutan viewing. Overall, orangutans had higher rates of self-directed behavior when they were social (within 50 meters of an independently ranging conspecific) than when they were alone [ $t(485.3) = -3.65, p < 0.05$ ]. Generalized linear mixed modeling was used to test for differences in rates of

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self-directed behavior based on the focal orangutan's age-sex class and the age-sex class of their social partner. This revealed that adolescent females had a significant increase in rate of self-directed behavior when social ( $p=0.047$ ) and that socializing with a flanged male significantly increased the rate of SDB ( $p<0.05$ ). We describe the social contexts in which orangutans display elevated rates of self-directed behavior and the implications of these findings for social development and the establishment of social relationships. We also discuss the potential utility of self-directed behavior as a metric for assessing dyadic relationships in a socially cryptic species that is revealing itself to have far greater social nuance than previously thought.

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### Great ape isotope ecology – moving beyond general patterns

VICKY M. OELZE

Department of Anthropology, UC Santa Cruz,  
Department of Primatology, Max Planck Institute for  
Evolutionary Anthropology

For over ten years, stable isotope research on extant primates including great apes has expanded and improved our general understanding of stable isotope patterns in fossil hominins and how these relate to past paleo-dietary niches. However, isotopic differences between great ape sites are still too often poorly understood due to the lack of comparative baseline vegetation data. Additionally, intra-individual isotopic and thus dietary variation relating to individual traits such as age, sex, reproductive state and dominance rank are still largely ignored or each trait is considered independently. Here, I show how stable isotope analysis is a useful tool to address various questions on feeding behavior in great apes, including niche separation in sympatric species, specialization to various habitats, seasonality, meat eating behavior and food preferences in reproductive females. I present an extensive stable carbon, nitrogen and oxygen isotope data set ( $n > 1000$ ) from all species of free-ranging African great apes (*Pan troglodytes*, *Pan paniscus*, *Gorilla sp.*) ranging from dense primary rainforest to open woodland-savanna. I illustrate how the integration of long-term observational data and statistical modeling can greatly improve the interpretation of isotope data and finally aid the application of the isotope approach in unhabituated and often critically endangered great ape communities.

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### An Isotopic Approach to Examining Culture Change at Casas Grandes, Mexico

ADRIANNE M. OFFENBECKER<sup>1</sup>, KYLE D. WALLER<sup>2</sup>,  
JANE H. KELLEY<sup>1</sup> and M. ANNE KATZENBERG<sup>1</sup>

<sup>1</sup>Department of Anthropology & Archaeology,  
University of Calgary, <sup>2</sup>Department of Anthropology,  
University of Missouri

Casas Grandes was one of the largest and most complex societies in prehistoric north-west Mexico, with established trade networks and social influences from Mesoamerica, the American Southwest, and west Mexico. The region experienced a cultural florescence during the Medio period (ca. 1200 – 1450 AD), which culminated in the construction and subsequent expansion of Paquimé, the type site of the culture area. One of the most contentious topics in Chihuahuan archaeology is whether Medio period culture change arose from in situ developments or from external stimuli, such as an influx of people from surrounding regions. To address this question, we use strontium and oxygen isotope analyses to determine the geographic origins of a subset of the individuals ( $N=95$ ) interred at both Paquimé and an earlier Viejo period site. If the Medio period florescence was due to outside influences, we would expect to see an increase in the number of non-local individuals when compared to the preceding Viejo period. Our results indicate that 31% of the Viejo period sample and 23% of the Medio period sample were comprised of individuals with non-local isotopic signatures. This difference was not statistically significant (Fisher's Exact,  $p = 0.4903$ ). As such, our data indicate that non-local individuals were present in both the Viejo and Medio periods and do not support the hypothesis that Medio period cultural florescence at Paquimé was due to a sudden influx of immigrants from surrounding regions.

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### Paleoclimate and Paleoenvironmental Reconstruction of the Early Miocene Fossil Site Koru 16 (Nyanza Province, Western Kenya) and Its Implications for Hominoid Evolution

KENNEDY OGINGA, DANIEL PEPPE, WILLIAM  
LUKENS and JAMES LUTZ

GEOLOGY, BAYLOR UNIVERSITY

The early Miocene fossil sites at Koru (Nyanza Province, western Kenya) document some of the earliest occurrences of large bodied hominoids like *Proconsul*. However, the paleoenvironment and paleoclimate of the sites is poorly understood, making it difficult to assess the habitat preferences of early hominoids and stem catarrhines. Here we report results of a detailed geologic study focused on reconstructing the

paleoclimate and paleoenvironment of one of the Koru sites, Koru 16.

The stratigraphic section at Koru 16 is ~8m thick and comprised of alternating deposits of medium to coarse sands and weakly-developed paleosols. All of the sediments contain relatively unweathered volcanic material indicating the site was frequently disturbed by eruptions from the nearby Tinderet volcanic complex. Shrink-swell features in the paleosols suggest that moisture was seasonally available. In the middle of the stratigraphic sequence there are abundant large drab-haloes root traces, fossil leaves, and casts of fossil branches, roots, and tree stumps. The close proximity of multiple stump casts of varying diameters within the same stratigraphic layer and size and shape characteristics of the fossil leaves suggest this interval may have been forested. The faunal assemblage at Koru 16 is consistent with a forested ecological setting, including relatively abundant and diverse primates. Taken together, our results suggest that the Koru 16 fossil site sampled a frequently disturbed and tropical seasonal forest environment, which adds to the growing body of work implicating the importance of both ecological disturbance and seasonal forested environments in the early evolution of hominoids.

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### Are developmental defects of enamel acquired according to seasonal schedules in Bornean gibbons and orangutans? An autocorrelation analysis

MACKIE O'HARA and DEBBIE  
GUATELLI-STEINBERG

Anthropology, The Ohio State University

Studies have suggested that great apes acquire linear enamel hypoplasia (LEH) on a regular, cyclical schedule corresponding to seasonal environmental patterns. However, these studies have been limited to averaging the amount of time between defects rather than considering the sequence of defects across an entire tooth. In addition, the possibility that dental defects might reflect seasonal environmental patterns has not been investigated in lesser apes. If environmental factors such as rainfall and fruit availability are driving cycles of physiological stress, then conspecific apes should exhibit similar schedules of dental developmental defects. This study tests this hypothesis in *Pongo pygmaeus* and *Hylobates muelleri* from Borneo by identifying sequences of dental developmental defects per individual and evaluating them using autocorrelation analysis. Autocorrelation analysis allows the full sequence of defects over an individual's crown formation period to be analyzed to identify cyclical patterns within the defect sequence. Additionally, the average number of perikymata

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between defects and the rate of acquisition per year were compared between the two species. *Hylobates muelleri* acquired more defects per year than *Pongo pygmaeus* and averaged less time between successive defects (calculated by multiplying the number of perikymata between defects by the species' striae of Retzius repeat interval range). Autocorrelation analysis did not reveal shared cyclical patterns of defect sequences in either species. However, some individuals did exhibit defects that formed according to a regular periodicity but that periodicity varied among individuals. These findings call into question the idea that environmental seasonality is driving defect acquisition in Asian apes.

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### Skewed Pattern of X Chromosome Inactivation in Brazilian Women

SILVIENE F. OLIVEIRA<sup>1,2</sup>, DIANA LM. BRANDÃO<sup>1</sup>, ALINE PIC-TAYLOR<sup>1,2</sup> and JULIANA FM. ARAÚJO<sup>3</sup>

<sup>1</sup>Genética e Morfologia, Universidade de Brasília, <sup>2</sup>Programa de Pós-graduação em Biologia Animal, Universidade de Brasília, <sup>3</sup>Faculdade de Medicina, Universidade de Brasília

X chromosome inactivation is a female biological phenomenon. A skewed pattern of this, i.e., when one of the parental chromosome is inactivated in at least 95% of the body cells, can represent structural variation or pathogenic mutations. We aim to establish the incidence of skewed X chromosome inactivation in a sample of Brazilian women (n = 102). Considering that several genes related to intellectual disability are in the X chromosome, the criterias for inclusion in the research was: a) woman above 35 years old, b) at least one biological normal mental health male child; c) no family record of X-linked mental impairment. Aiming to access a proportion of each parental X-chromosome inactivation, it was analyzed a STR located in the ARX gene, one of the X methylated gene. We observed skewed X-inactivation in four women (3%), considering full skewed inactivation as  $\geq 95:5$  or  $\geq 5:95$ , and 26 women (25.5% of the sample) considering as  $\geq 80:20$  or  $\geq 20:80$ . These are the highest value described for a population. Karyotype analysis and cytoscan affymetrix microarray showed no structural variation in the four full skewed X chromosome. While this sample showed that 46% of these women has cancer history in at least one family member, this number is higher among the skewed X chromosome inactivation women – 65% suggesting an association cancer and skewed X chromosome inactivation in Brazilian populations.

Acknowledgments: CNPq and FAPDF

### Dietary Differences of Two Sympatric Folivorous Indriids as a Mechanism for Niche Separation in a Highly Seasonal Island Environment

LANA K. OLIVER

Anthropology, Washington University in Saint Louis

The extant lemurs of Madagascar are the result of a unique adaptive radiation of primates from a small founder population over 60 million years ago. As such, the island acts as an evolutionary laboratory for the study of how species evolve to inhabit specific environmental niches. Seasonal fluctuations in temperature, rainfall and resource availability require sympatric lemur species to differentially exploit their environment to successfully coexist. The indris (*Indri indri*) and diademeds (*Propithecus diadema diadema*) sifakas are two large-bodied confamilial lemurs from the family Indridae. They are sympatric throughout much of their species range and inhabit Madagascar's northeastern rainforests. Both are considered anatomical folivores but interspecific differences in mandibular shape, molar shearing crests and gut morphology suggest that the indri is more highly specialized for folivory whereas the diademmed sifaka can exploit a more diverse diet. I collected data on the feeding behavior of indri and diademmed sifakas over an annual cycle (April 2013 – March 2014) to determine species-specific differences in the number of plant species used and preferences regarding plant part consumption. As their morphology suggests, diademmed sifakas fed on more plant species (min. N = 127) than did indri (min. N = 67). Additionally, indri fed on proportionally more bark, and immature leaves while diademmed sifakas had a comparatively higher proportion of fruits and seeds in their diet. Dietary overlap occurred in more abundant plant species. This study provides insight into how morphology and ecology are intertwined to maintain coexistence of sympatric species.

Saint Louis Zoo WildCare Institute, Mohammed bin Zayed Species Conservation Fund, Washington University Department of Anthropology

### The Effects of Pathology on the Intra-tissue Carbon and Nitrogen Isotopic Variability of Human Bone Collagen

KARYN C. OLSEN<sup>1</sup>, CHRISTINE D. WHITE<sup>1</sup>, FRED J. LONGSTAFFE<sup>2</sup>, KRISTEN VON HEYKING<sup>3</sup>, GEORGE MCGLYNN<sup>4</sup>, GISELA GRUPE<sup>3,4</sup> and FRANK J. RÜHLI<sup>5</sup>

<sup>1</sup>Department of Anthropology, Western University, <sup>2</sup>Department of Earth Sciences, Western University, <sup>3</sup>Department of Biology I, Biodiversity/Anthropology, Ludwig-Maximilians-University Munich, <sup>4</sup>State Collection for Anthropology and Palaeoanatomy, Bavarian Natural History Collections (SNSB), <sup>5</sup>Institute of Evolutionary Medicine, University of Zurich

This research investigates the influence of several diseases common to ancient populations on

bone collagen isotopic compositions ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ). Differences in collagen  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  are traditionally interpreted as indicators of dietary distinction even though physiological processes likely play some role in creating variation. We tested examples of degenerative joint disease (osteoarthritis), metabolic disease (rickets/osteomalacia), trauma (fracture), inflammation (periostitis), and infection (osteomyelitis) using samples derived from two medieval German cemeteries and one Swiss reference collection. Each test compared bone lesion collagen to sites both near and distant to the lesion. We also tested visibly nonpathological samples from the German collections to establish normal isotopic variation within the skeleton. Results showed low intraskeletal variation in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  among visibly nonpathological skeletons but significant intraskeletal differences for individuals with osteomyelitis, healed fractures, and osteoarthritis. Individuals with periostitis exhibited significant intraskeletal differences in  $\delta^{15}\text{N}$  only, while those with rickets/osteomalacia displayed no significant intraskeletal differences. We suggest paleodiet researchers avoid sampling collagen at or close to bone lesion sites given that the disrupted body metabolism associated with some diseases obscures dietary signals.

### Evidence for Handedness in Termite Fishing among Gombe Chimpanzees

MATTHEW FERRY<sup>1</sup>, LINDA F. MARCHANT<sup>2</sup> and ROBERT C. O'MALLEY<sup>3</sup>

<sup>1</sup>Anthropology, The National Museum of Natural History, <sup>2</sup>Anthropology, Miami University, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University

Humans exhibit manual lateralization or "handedness," showing population-level right-hand dominance across a range of tasks, but most strongly in complex manipulation such as tool-use. Though many organisms demonstrate behavioral asymmetries, the strength of the evidence for population-level handedness in nonhuman primates (and particularly in apes) remains contentious. Among chimpanzees (*Pan troglodytes*), some studies of captive populations have reported population-level right-hand biases across a range of tasks. In wild populations the evidence is more equivocal. Left- and right-hand lateralization by individual chimpanzees is documented most consistently in coordinated bimanual activities and/or forms of tool-use. For 'termite-fishing,' a habitual tool-use behavior of chimpanzees in Gombe National Park, Tanzania, prior studies have reported individual but not population-level handedness (McGrew and Marchant 1996) and a population-level left-hand bias (Lonsdorf and Hopkins 2005), respectively.

To expand the available data on handedness in this well-studied population and task, and to assess the consistency of handedness within

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subjects across time periods and studies, we analyzed hand use during termite-fishing by Gombe chimpanzees observed in 2008. Our methods were comparable to prior studies. Most subjects (17/19) were individually lateralized ( $p < 0.05$ ), though only 36.8% (7/19) were *exclusively* left- or right-handed in termite-fishing. Among lateralized individuals, we did not find a population-level left-hand bias (11/17;  $p = 0.07$ ). All individuals demonstrating manual lateralization in prior studies remained lateralized in the same direction in this study. We evaluate several explanations, including scoring methodology, for the patterns of individual and population-level handedness reported for this task across different studies.

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### Large mammal community structure and habitat variability in eastern and southern African *Paranthropus*

KELSEY D. O'NEILL<sup>1</sup>, AMY L. RECTOR<sup>2</sup> and CHRISTINE STEININGER<sup>3</sup>

<sup>1</sup>Department of Biology, Virginia Commonwealth University, <sup>2</sup>Anthropology, School of World Studies, Virginia Commonwealth University, <sup>3</sup>Evolutionary Studies Institute, University of the Witwatersrand

*Paranthropus robustus* and *Paranthropus boisei* overlapped temporally and shared derived chewing adaptations associated with tough foods. However, they differed in their geographic distribution as well as potentially in their ecological contexts. Isotope and microwear data from *P. robustus* suggest that the South African robust australopith may have relied on a diet different from that of the east African species.

To compare the paleoecological contexts of *P. robustus* and *P. boisei*, the associated assemblages of large mammals from 11 South African and 6 east African *Paranthropus* sites were analyzed using a community approach. Multivariate correspondence analyses were used to compare the fossil communities to 191 extant communities in modern African habitats. The modern African sample includes abiotic variables such as mean annual temperature and seasonality, annual range in temperature, annual precipitation, and precipitation seasonality. Using presence/absence data of 243 extant large mammal species and their locomotor and dietary adaptations, modern communities were described in terms of the abiotic data, and this variability was used to retrodict community affinities that would have served as ecological parameters for *P. robustus* and *P. boisei*.

Multivariate analyses suggest that the communities of large mammals associated with *P. robustus* sampled a range of habitats, but most

were ecologically similar to those of extant African shrublands and were fairly dry. *P. boisei* sites were reconstructed as generally wetter, suggesting that *P. robustus* and *P. boisei*, while both able to take advantage of a limited range of habitats, in fact existed in significantly different ecological contexts.

### Pelvis shape, lumbar column length and the origin of the hominin walking stride

MATTHEW C. O'NEILL<sup>1</sup>, NAOMICHI OGIHARA<sup>2</sup>, MASATO NAKATSUKASA<sup>3</sup>, BRIGITTE DEMES<sup>4</sup>, NATHAN E. THOMPSON<sup>5</sup> and BRIAN R. UMBERGER<sup>6</sup>

<sup>1</sup>Basic Medical Sciences, University of Arizona College of Medicine - Phoenix, <sup>2</sup>Department of Mechanical Engineering, Keio University, <sup>3</sup>Laboratory of Physical Anthropology, Kyoto University, <sup>4</sup>Department of Anatomical Sciences, Stony Brook University School of Medicine, <sup>5</sup>Department of Anatomy, New York Institute of Technology, <sup>6</sup>Department of Kinesiology, University of Massachusetts, Amherst

Humans are unique among apes and other primates in the musculoskeletal design of their lower back and pelvis. While the last common ancestor of the *Pan-Homo* lineages has long been thought to be African ape-like, recent descriptions of early hominin and Miocene ape fossils have led to the proposal that lower back and pelvis shape was more similar to that of some Old World monkeys, such as macaques. Here, we compare three-dimensional kinematics of the pelvis and hind limbs of highly-trained bipedal macaques, bipedal chimpanzees and humans during a bipedal walking stride.

Marker data from highly-trained bipedal macaques (N=2), bipedal chimpanzees (N=3) and humans (N=3) walking at similar dimensionless speeds were integrated with species-specific three-dimensional musculoskeletal models to calculate pelvis and hind limb motion via inverse kinematics. Zero-lag cross-correlations and root mean squared errors were used to compare joint motion between species.

Our results indicate that the locomotor kinematics of bipedal macaques and bipedal chimpanzees are remarkably similar, with both species differing in similar ways from humans. The main differences between macaques and chimpanzees were in pelvis tilt and hip abduction, but these differences were small in magnitude when contrasted with humans. Our results suggest that regardless of whether *Pan* and *Homo* diverged from a common ancestor whose lower back and pelvis was more 'African ape-like' or 'Old World monkey-like', at its origin, the hominin walking stride involved pelvis motion distinct from humans, and flexed, abducted hind limbs.

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### Three Years of Sampling the Gut Microbiota of Free-ranging Capuchin Monkeys (*Cebus capucinus imitator*) in a Tropical Dry Forest

JOSEPH D. ORKIN<sup>1</sup>, SHASTA E. WEBB<sup>1</sup> and AMANDA D. MELIN<sup>1,2</sup>

<sup>1</sup>Department of Anthropology and Archaeology, University of Calgary, <sup>2</sup>Department of Medical Genetics, University of Calgary

Understanding the composition of the microbiota of wild primate populations provides comparative insight into the microbiomes of ancient and contemporary human foraging populations, and potentially those of archaic hominins. Rapid turnover of gut microbiota is possible, and microbial shifts can affect metabolism and immune response. However, a deeper understanding of the determining factors requires long-term data on stability and variation within and among individuals. Longitudinal examinations of microbial communities in free-ranging primates are limited, and the degree of interannual variation remains unknown.

We undertook a multi-year, longitudinal study of the primates inhabiting the tropical dry forests in Sector Santa Rosa, Área de Conservación Guanacaste, Costa Rica. We have been collecting fresh fecal samples seasonally from three groups (24 individuals) of capuchin monkeys (*Cebus capucinus imitator*) since April, 2014. Samples were frozen in liquid nitrogen in the field then stored at -80°C prior to the extraction of microbial DNA. Libraries were constructed for 16S V4 rRNA metabarcoding, sequenced with an Illumina MiSeq, and analyzed with phyloseq and DESeq in R. A subset of these samples also underwent whole metagenomic shotgun sequencing on an Illumina NextSeq, and were analyzed with the HUMAnN2 pipeline for functional associations. We identified significant changes in bacterial taxa across seasons, particularly among Proteobacteria, Firmicutes, and Bacteroidetes. Our results indicate that substantial variation in gut microbial communities occurs across time, which should be considered in future studies. Furthermore, an understanding of seasonal variation in the capuchin gut microbiome will reveal health impacts of seasonal drought and food shortage.

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# ABSTRACTS

## Tracking Hylobatid Taxonomic Diversity from Molar Morphometrics

ALEJANDRA ORTIZ<sup>1,2,3</sup>, CATALINA I. VILLAMIL<sup>2,3</sup>, CLARE M. KIMOCK<sup>2,3</sup>, KAI HE<sup>4,5</sup> and TERRY HARRISON<sup>2,3</sup>

<sup>1</sup>Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Center for the Study of Human Origins, Department of Anthropology, New York University, <sup>3</sup>New York Consortium in Evolutionary Primatology, NYCEP, <sup>4</sup>Kunming Institute of Zoology, Chinese Academy of Sciences, <sup>5</sup>The Kyoto University Museum, Kyoto University

Gibbons and siamangs (family Hylobatidae) are small apes inhabiting the rainforests of South and Southeast Asia. There are up to 18 extant species, apportioned among four genera (*Hylobates*, *Hoolock*, *Nomascus* and *Symphalangus*). Although hylobatids share a suite of dental and skeletal specializations that distinguish them from other apes, differences in hard tissue features within the Hylobatidae are extremely subtle, limiting our ability to identify fossil specimens at lower taxonomic levels. Here we quantified size and shape differences in the upper and lower molars of 279 extant hylobatids (913 molars), representing 13 species from all four genera. Cusp angles and areas were collected from digital photographs of the occlusal surface using image-processing software. Crown outlines were analyzed using geometric morphometrics methods and then submitted to discriminant analyses (DFAs) to determine differences between genera. These results were mapped onto phylogenetic trees to ascertain the role of phylogeny in hylobatid molar morphology. In the upper molars, *Hylobates* cusp angles appear to be highly derived. However, in the lower molars, it is *Symphalangus* that diverges from other hylobatids, with a relatively larger metaconid and hypoconid. The DFAs show significant differences in molar shape between hylobatid genera, although the phylogenetic component of this variation is not significant for any tooth. LM1 outline in particular provided a highly accurate classification (~93% accuracy). Considering that the hylobatid fossil record consists primarily of isolated teeth of unknown generic and specific affiliation, our results have implications for understanding hylobatid biogeography and evolutionary relationships.

## Regional Variation and Sexual Dimorphism in the Ontogeny of Humeral Asymmetry among Prehistoric Hunter-Gatherers

BENJAMIN OSIPOV<sup>1</sup>, LESLEY HARRINGTON<sup>1</sup>, LIBBY COWGILL<sup>2</sup>, DANIEL TEMPLE<sup>3</sup>, VALDIMIR I. BAZALIISKI<sup>4</sup> and ANDRZEJ W. WEBER<sup>1,5</sup>

<sup>1</sup>Anthropology, University of Alberta, <sup>2</sup>Anthropology, University of Missouri, <sup>3</sup>Sociology and Anthropology, George Mason University, <sup>4</sup>Archaeology and Ethnography, Irkutsk State University, <sup>5</sup>Laboratoire

Méditerranéen de Préhistoire Europe Afrique (LAMPEA), Aix-Marseille Université

The study of humeral asymmetry assists in reconstructing the behavior of past human populations. We study the ontogeny of humeral asymmetry in hunter gatherer populations to broaden understanding of when and why behavioral differences between populations develop during growth.

Humeral midshaft asymmetry in Total Area (TA) and torsional rigidity (J) was evaluated for juveniles and young adults from four populations: Early Neolithic Cis-Baikal, Siberia (7503 ± 14 to 7027 ± 33 mean HPD cal BP), Late Neolithic/ Early Bronze Age Cis-Baikal, Siberia (7027 ± 33-3726 ± 34 mean HPD cal BP), Point Hope, Alaska (2,100-300 BP), and Later Stone Age South Africa (8,000-800 BP). Arm asymmetry was compared separately for individuals younger or older than 13. Comparisons were also made between male and female adolescents and young adults.

Results demonstrate no significant differences in humeral asymmetry among groups prior to adolescence. Adolescent Late Neolithic/ Early Bronze Age Cis-Baikal individuals have significantly lower TA but not J than the Later Stone Age group. Homogeneity in Point Hope and Cis-Baikal asymmetry trajectories may indicate behavioral adaptation to a broadly similar ecology. Adolescent Later Stone Age males have significantly higher values of TA and J than Later Stone Age females, Cis-Baikal males and females, and Point Hope adolescents of indeterminate sex. High levels of asymmetry among Later Stone Age adolescent and young adult males suggests habitual use of specific hunting tools. Overall results indicate that population differences in humeral asymmetry become visible in adolescence and likely reflect the commencement of adult foraging behaviors.

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## Bodies in Motion: Migration and Identity in Bronze Age Cyprus

ANNA J. OSTERHOLTZ

Anthropology and Middle Eastern Cultures, Mississippi State University

During the Prehistoric Bronze Age (2400-1700 BC) through the late Protohistoric Bronze Age (1700-1150 BC) the island of Cyprus saw numerous cultural and subsistence changes including agricultural intensification, the rise of copper production, and the increasing prominence of Cyprus within the larger regional sphere. During these periods of rapid social change, groups migrated to the island. Archaeologists have argued two conflicting models for the population expansions: external colonization and migration with integration. They do this through

analysis of architecture, ceramics, and other artifact classes. A bioarchaeological model for colonization is presented, with expectations for increased trauma and decreased health scores for populations. Going from individual tombs to regions to examining the island as a whole, analysis of health, robusticity and trauma data were used to examine the interaction of incoming and native Cypriot groups.

Essentially, the biological data support a model of migration and integration of populations that likely had long standing social and economic ties before population migration. Social changes are evident in the populations, but decreased health and increased trauma are not evident. The role of migration is also examined with respect to identity and the creation of a third space phenomenon.

## walkR: A Software Package to Analyze the Biomechanics of Human Locomotion

ERIK R. OTAROLA-CASTILLO<sup>1</sup>, ERIC R. CASTILLO<sup>2</sup>, MARTIN HORA<sup>3</sup>, MELISSA G. TORQUATO<sup>1</sup>, ANNA G. WARRENER<sup>4</sup> and HERMAN PONTZER<sup>5</sup>

<sup>1</sup>Anthropology, Purdue University, <sup>2</sup>Human Evolutionary Biology, Harvard University, <sup>3</sup>Anthropology and Human Genetics, Charles University, Prague, <sup>4</sup>Anthropology, University of Colorado, Denver, <sup>5</sup>Anthropology, Hunter College

Hominin evolution is marked by radical changes in locomotor anatomy and mechanics, exemplified by humans' unique bipedal walking and running gait. Mechanical analyses of human walking and running are therefore useful for testing hypotheses in paleoanthropology, but these studies are limited by the lack of validated, freely available, open-source analysis platforms that allow researchers to compare results across research laboratories and study populations. Here, we present "walkR," a statistical package within the R computing environment to analyze the kinematics and kinetics of human walking and running. Functions in walkR allow users to read, process, display and analyze the data necessary for inverse dynamics and other biomechanical analyses including spatiotemporal variables, joint angles, joint moments and muscle forces. The walkR package is open source, freely distributed, and customizable, making research replication easier. Moreover, its graphical user interface within the R computing environment is easy to use. As a proof of concept, we provide an analytical example using previously analyzed force-platform (AMTI model-OR, 1000Hz) and motion capture data (Vicon, 200Hz) for 20 subjects during walking and running trials. Joint moments and muscle forces were compared between standard Matlab routines and the functions in walkR. These comparisons show that walkR produces reliable results that are identical to the standard software used for these analyses.

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### Y-chromosome STR analysis of ancient individuals from British Columbia

AMANDA C. OWINGS<sup>1</sup>, JEROME S. CYBULSKI<sup>4</sup> and RIPAN S. MALHI<sup>1,2,3</sup>

<sup>1</sup>Program in Ecology, Evolution and Conservation Biology, University of Illinois at Urbana Champaign, <sup>2</sup>Department of Anthropology, College of Liberal Arts and Sciences, University of Illinois at Urbana Champaign, <sup>3</sup>Carl R. Woese Institute for Genomic Biology, University of Illinois at Urbana Champaign, <sup>4</sup>Archaeology and History Department, Canadian Museum of History, Gatineau, Quebec

Archaeological sites on the north coast of British Columbia, Canada, in and about Prince Rupert Harbour, indicate a Tsimshian First Nations presence dating back 6000 years. European colonization in the 18<sup>th</sup> Century CE brought about a complicated history of disease and displacement of the Tsimshian living in the region. From the sites themselves, more than 250 individuals have been unearthed. Mitochondrial genomes have identified closely related or identical haplotypes in the ancients and in the living. One study found a 57% reduction in effective population size between these related peoples. Because the effects of colonization may have been different for men and women, we undertook a study of paternal DNA. While studies of the Y-chromosome may be limited given the difficulty in retrieving such DNA from ancient individuals, our preliminary analysis revealed a 40% decrease in Y-chromosome diversity between the ancients and the living. We present Y-chromosome STR data for 30 ancient and 48 living men. Using up to 23 Y-STRs, we determined that the ancient men have about 20% C and 80% Q haplogroups. Living Tsimshian have approximately 60% Eurasian Y admixture and no haplotypes are shared with ancient individuals. The closest two individuals are different by three STRs. Sex-biased survival is suggested with Y haplotypes from the ancient men not being found in the living population as was the case with the mitochondrial genomes.

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### The dawn of dentistry in the Late Upper Paleolithic

GREGORIO MR. OXILIA<sup>1,2</sup>, FLAVIA MS. FIORILLO<sup>3</sup>, FRANCESCO DR. BOSCHIN<sup>4,5</sup>, ELISABETTA DR. BOARETTO<sup>6</sup>, SALVATORE ANDREA MR. APICELLA<sup>3</sup>, CHIARA DR. MATTEUCCI<sup>3</sup>, DANIELE DR. PANETTA<sup>7</sup>, ROSSELLA PROF. PISTOCCHI<sup>8</sup>, FRANCA PROF. GUERRINI<sup>9</sup>, CRISTIANA MS. MARGHERITA<sup>2</sup>, MASSIMO DR. ANDRETTA<sup>9</sup>, RITA MS. SORRENTINO<sup>10,2</sup>, GIOVANNI PROF. BOSCHIAN<sup>11</sup>, SIMONA MS. ARRIGHI<sup>4,5</sup>, IRENE DR. DORI<sup>1</sup>, GIUSEPPE MR. MANCUSO<sup>2</sup>, JACOPO DR. CREZZINI<sup>4,5</sup>, ALESSANDRO DR. RIGA<sup>1</sup>, MARIA CRISTINA MS. SERRANGELI<sup>2</sup>, ANTONINO MR. VAZZANA<sup>2</sup>, PIERO PROF. SALVADORI<sup>7</sup>, MARIANGELA PROF. VANDINI<sup>3</sup>, CARLO PROF. TOZZI<sup>1,2</sup>, ADRIANA PROF. MORONI<sup>4,5</sup>, ROBIN DR.

FEENEY<sup>1,3</sup>, JOHN DR. WILLMAN<sup>1,4</sup>, JACOPO PROF. MOGGI-CECCHI<sup>1</sup> and STEFANO DR. BENAZZI<sup>1,5,2</sup>

<sup>1</sup>Department of Biology, University of Florence, <sup>2</sup>Department of Cultural Heritage - Laboratory of Anthropology, University of Bologna, <sup>3</sup>Department of Cultural Heritage - Conservation Science Laboratory for Cultural Heritage, University of Bologna, <sup>4</sup>Study Centre for the Quaternary Period, CeSQ, <sup>5</sup>Department of Physical Sciences, Earth and Environment, University of Siena, <sup>6</sup>Max Planck-Weizmann, Center for Integrative Archaeology and Anthropology, <sup>7</sup>Institute of Clinical Physiology, IFC-CNR, <sup>8</sup>Department of Biological, Geological and Environmental Sciences, University of Bologna, <sup>9</sup>School of Science, University of Bologna, <sup>10</sup>BiGeA - Department of Biological, Geological and Environmental Sciences, University of Bologna, <sup>11</sup>Department of Biology, University of Pisa, <sup>12</sup>Department of Civilisations and Forms of Knowledge, University of Pisa, <sup>13</sup>School of Medicine, Health Science Centre, University College Dublin, <sup>14</sup>Department of Anthropology, Washington University, <sup>15</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Evidence for prehistoric treatment of dental pathology is observed primarily among food-producing societies with highly cariogenic diets. Despite the growing evidence of a decline in oral health during the Late Upper Paleolithic, current data would suggest that modern humans did not practice therapeutic dentistry prior to the Neolithic. Here we report the earliest evidence for dentistry in a Late Upper Paleolithic hunter-gatherer from Riparo Fredian (Tuscany, Italy). A direct chronometric date for Fredian 5 confirms a Late Upper Paleolithic context (between 13,000-12,735 calendar years ago). Both upper central incisors of Fredian 5 display exposed pulp chambers with chipped dentine on the cavity margins, striations on the cavity walls and circumferential enlargement. Fourier transform infrared spectroscopy (FTIR), energy dispersion X-ray spectroscopy (EDS), and Raman microscopy analysis of black residue adhering to the walls of both cavities is consistent with organic substances, specifically bitumen. Histochemical analysis of the material embedded at the bottom of the cavities revealed a conglomerate of vegetal fibers and probably hairs. Our results are consistent with *in vivo* dental drilling to remove necrotic or infected pulp tissue (*pulpitis*) and the subsequent use of a composite, organic dental filling in the cavity. Therefore, Fredian 5 confirms the oldest practice of dentistry – specifically, pathology-induced surgical intervention – among Late Upper Paleolithic hunter-gatherers, suggesting that fundamental perceptions of biomedical knowledge and practice were in place long before the sociocultural changes associated with the transition to food production in the Neolithic.

### Chimpanzees of the past: Full mitochondrial genomes from *Pan troglodytes schweinfurthii* skeletons from Gombe National Park

ANDREW T. OZGA<sup>1</sup>, MARIA A. NIEVES-COLON<sup>2</sup>, REBECCA NOCKERTS<sup>3</sup>, MICHAEL L. WILSON<sup>3,4</sup>, IAN C. GILBY<sup>1,2</sup>, ANNE PUSEY<sup>5</sup> and ANNE C. STONE<sup>1,2</sup>

<sup>1</sup>Institute of Human Origins, Arizona State University, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Department of Anthropology, University of Minnesota, <sup>4</sup>Department of Ecology, Evolution and Behavior, University of Minnesota, <sup>5</sup>Evolutionary Anthropology Department, Duke University

The tropical environment of Gombe National Park, Tanzania makes the recovery of endogenous genetic material from skeletal remains inherently difficult. Since the 1960's many of the *Pan troglodytes schweinfurthii* skeletons were interred under circumstances not conducive to adequate DNA preservation. To date, no skeletal material has yielded usable DNA, despite the relatively young age of the samples. Here, for the first time, using novel extraction methods, we capture chimpanzee DNA from dentin and calcified dental plaque (calculus) in order to address questions about overall preservation and genetic diversity within several generations of Gombe National Park inhabitants. DNA was extracted from a total of 28 chimpanzees (9 dentin and 28 calculus samples) and built into double-stranded shotgun libraries. Amplified libraries underwent in-solution hybridization capture enrichment and were sequenced on an Illumina MiSeq (v2, 2x150 paired end) in order to obtain complete mitochondrial genomes (mitogenomes). We were able to reconstruct successfully the mitogenomes from all 9 dentin samples (240x mean coverage at 100%) and 28 calculus samples (37x mean coverage at 98%). We used mitogenomes to conduct an exploratory survey of genetic diversity over time at Gombe. When combined with publicly available *P.t. schweinfurthii* HV1 data, we found that haplotype diversity of chimpanzees who died before 1992 was slightly higher than those who died after (0.862 compared to 0.824). These preliminary results mark the first mitogenomes reconstructed from deceased Gombe chimpanzee calculus and further validate the use of the biological material as a reservoir for host DNA.

### The Number of Male and Female *Simakobus (Simias concolor)* on the Pagai Islands, West Sumatra, Indonesia

LISA M. PACIULLI, ANMOL SHARMA and KATIE ALTABET

Biological Sciences, North Carolina State University

Population growth and the number of births in a group are related to the number of females. *Simakobu* monkeys (*Simias concolor*) live on the Mentawai Islands, West Sumatra, Indonesia. Data

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previously collected from line transect surveys at nine sites - three that were logged ~ten years before data collection, three logged ~twenty years before, and three unlogged sites - were analyzed. The minimum number of individuals detected at a site was four, while the maximum was 78. An average number of 48 adult *simakobus* were detected at the unlogged sites, while an average of 41 and 14 were detected in the logged-ten and logged-twenty areas, respectively. Of these, there was an average of 42 males in unlogged forests, 20 in forests logged ten years prior, and 15 in forests logged twenty years before. In contrast, an average of only eight females were positively identified in unlogged forests, 14 in the logged-ten forests, and no females were found in forests logged twenty years before. The drastically lower number of females is in stark contrast to the 1:3 sex ratio found by Erb *et al.* (2012) on Siberut. It is unclear if there are fewer adult females on the Pagai Islands due to hunters targeting them, or because females are less visible, and/or due to a sampling artifact. Future analyses will focus on the number of individuals that were detected but not positively identified, and how this impacts the possible number of females and sex ratio of Pagai Island *simakobus*.

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### Reproductive Value across the Holocene: 8,000-years of Transitions

RICHARD R. PAINE<sup>1</sup> and JESPER L. BOLDSSEN<sup>2</sup>

<sup>1</sup>Anthropology, University of Utah, <sup>2</sup>ADBOU, University of Southern Denmark

The goal of this study is to examine effects of increased epidemic frequency on life history patterns in Holocene Central Europe. Preliminary analysis of a database of 14,000 skeletons from central and northern Europe, covering approximately 8,000 years from the Mesolithic through the late Medieval periods, revealed two distinct trends in child mortality. First, beginning in the Neolithic, the relative risk of death of older children (5-18 years) increased relative to younger children (2-5). This increase continued for 6,000 years. Second, beginning approximately 2000 years ago this trend reversed. The decrease in relative risk for older children continued through the late Medieval period.

We hypothesized these trends resulted from increasing frequency of epidemic diseases as European populations became larger, denser, and more connected to larger disease pools. To test this hypothesis, we simulated increased epidemic frequency using Leslie matrix projections. These projections captured both child mortality trends.

In the latest stage of our research, we assessed the relative reproductive value of newborns versus older children using model death distributions

from the Leslie matrix projections and Fisher's reproductive value equation. The reproductive value of both 3-year-olds and 18-year-olds declines beginning in the Neolithic. Eighteen-year-olds begin to rebound approximately 2000 ago. Three-year-old reproductive value continued to decline through the early Medieval.

Life history theory predicts decreased  $V_x$  for existing children and juveniles would select for earlier onset of reproduction and for increased investment in additional offspring versus existing offspring. This result fits early historical-demographic observations of fertility and marriage patterns in Europe.

### After 25 years, revisiting clavicle histology

ROBERT R. PAINE

Sociology, Anthropology & SW, Texas Tech University

Since Kerley (1965), forensic anthropologists have been using bone micro-anatomy to estimate age-at-death. At first, only micro-anatomy of the leg bones were used for this purpose; by Kerley and then by others (Ahlqvist & Damsten, 1969; Singh & Gunberg 1970; Thompson 1980; Ericksen 1991). By 1992 Stout and Paine introduced histological data from the left 6<sup>th</sup> rib and left clavicle for age-at-death assessment, thus adding two new skeletal regions for this purpose. After 25 years, much has been said of rib histology when it comes to age determination but little has been done specific to using clavicular histology. In review, at least two graduate projects have explored this topic, as well as an ethnic population specific publication using micro-anatomy from South Koreans (Lee *et al.*, 2014). This presentation revisits age-at-death estimation using clavicle micro-anatomy. Specifically, 45 individuals are examined histologically. Their OPD values are used in the equations provided by both Lee *et al.*, (2014) and Stout and Paine, (1992). The 45 individuals are of known age-at-death, (mean age 35 years). The clavicle samples offer a mean OPD of 15.36 and an OPD range of 5.6 - 28.7. The equations use slightly different variables;  $\ln \text{age} = 2.216 + 0.070280 (\text{OPD}_c)$ ; and  $\text{age} = 1.412 - 0.282 (\text{RCA}) + 2.519 (\text{OPD})$ . The main difference between the equations is that cortical area is used twice in the Lee *et al.* (2014) equation. As it turns, out both equations provide similar age estimations; supporting Lee's *et al.*'s original findings.

### A proposed method for scoring subadult enthesal morphology

JESSICA L. A. PALMER<sup>1</sup>, ANDREA L. WATERS-RIST<sup>1</sup> and ANGELA LIEVERSE<sup>2</sup>

<sup>1</sup>Faculty of Archaeology, Leiden University,

<sup>2</sup>Department of Archaeology and Anthropology, University of Saskatchewan

Past research into morphological changes to muscle and ligament attachment sites (entheses)

on bone has focused solely on adults, with the development of several scoring methods aimed at discerning *intra vitam* muscle morphology as an indirect indicator of types and levels of past physical activity. However, these methods cannot be applied to subadult bone due to intrinsic differences in how soft tissue attaches to developing bone, as compared to how it attaches to adult bone. Therefore, to start analyzing variations in enthesal morphology of subadults, we present a newly developed method to score enthesal changes in growing individuals. Separate descriptions are created for seventeen sites on subadult bones: four fibrocartilaginous entheses and thirteen fibrous entheses from the upper and lower limb. Enteses were chosen based on their location, i.e., distant from sites of epiphyseal fusion, and visibility, i.e., distinguishable and delineated. Descriptions and photographs are created to aid classification of each entesis into a score between zero and three, with zero meaning the entesis cannot be perceived, and three meaning maximum amount of osseous change. The scoring system was applied by two experts and one non-expert on eight individuals aged three through seventeen years from the skeletal collection of Middenbeemster (The Netherlands). This method is a first step to better understanding the development and individual variation of enteses among subadults, with the goal of informing on overlying muscle and ligament morphology and, ultimately, possible links with activity patterns.

### Platyrrhine dynamic dental topography: implications for secondary dental morphology in brachyodont, long-lived taxa

JAMES D. PAMPUSH<sup>1</sup>, JACKSON P. SPRADLEY<sup>1</sup>, JUSTIN T. GLADMAN<sup>2</sup>, DARBI GRIFFITH<sup>1</sup>, LAUREN A. GONZALES<sup>1</sup> and RICHARD F. KAY<sup>1,3</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Shared Material Instrumentation Facility (SMIF), Duke University, <sup>3</sup>Division of Earth and Ocean Sciences, Nicholas School of the Environment, Duke University

Platyrrhine primates are relatively long-lived mammals but paradoxically have low-crowned thinly enameled cheek teeth that are particularly susceptible to lifetime-wear, likely diminishing their functional abilities. Folivorous taxa like *Alouatta* soon experience occlusal surface alteration characterized by enamel perforation and dentine cupping wear, termed macrowear. The question therefore arises: does this sort of wear lead to a decline in masticatory performance, or is macrowear adaptively harnessed to maintain or even enhance functionality? Furthermore, does macrowear act to maintain or improve performance in all species equally, or is this effect predominantly limited to species that have higher-fiber diets? To investigate this problem, we compared wear-induced alterations to the surface topography in samples of two species of atelid platyrrhines: [1] the high-fiber consuming

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*Alouatta*; and [2] the less fiber consuming *Ateles*. Preliminary results suggest that the relative sharpness of the crests on the molar occlusal surfaces of *Alouatta* spp.—as measured with Dirichlet Normal Energy (DNE)—initially increases with macrowear (as dentine is exposed) and continues to be high until very late stages of wear, whereas the same effect is not observed (or observed only to a limited degree) in *Ateles* spp. This result adds tentative support to the folivory-based ‘dental sculpting’ phenomenon presumed to be an adaptation to both [1] improve food breakdown through harnessing—not avoiding—high levels of macrowear; and [2] forestalling dental senescence in this long-lived brachyodont folivore.

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### Assessing skeletal indicators of childhood stress amongst 20<sup>th</sup> century northeastern (Isan) Thais

MARIA PANAKHYO<sup>1</sup> and NAWAPORN TECHATAWEEWAN<sup>2</sup>

<sup>1</sup>Anthropology, Southern Illinois University, <sup>2</sup>Anatomy, Khon Kaen University

The Human Skeleton Research Collection at Khon Kaen University houses the skeletal remains of modern, Twentieth Century Thai individuals and provides an important opportunity to examine how changes in society and economics affect skeletal health. This study utilized the collection to assess how economic growth occurring after World War II affected the childhood growth of individuals living in the northeast (Isan) region of Thailand. Quantification of childhood growth consisted of estimating the stature and observing the presence or absence of porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasias in 172 adult skeletons (pre-WWII females n=21, pre-WWII males n=52, post-WWII females=50, post-WWII males n=49) ranging in age from 28 to 93 years old. Statistical analyses indicate no significant difference between people born before and after WWII in terms of stature ( $p=0.637$ ), porotic hyperostosis and cribra orbitalia ( $p=0.819$ ), or linear enamel hypoplasias ( $p=0.869$ ). Likewise, there were no statistically significant differences between males and females ( $0.61 \leq p \leq 1.00$ ), with the exception of stature ( $p=0.0004$ ). These findings suggest post-WWII economic changes, in the form of domestic development and reinvestment, may have had subtler influences on those living in the northeast region than what was expected. The implications of this study are critical to understanding how modern social and economic developments can affect the physiological health of a population. Furthermore, known medical information on the presence of anemic conditions and dietary patterns within a living population can help refine our understanding of the manifestation of skeletal lesions

used to diagnose anemia and nutritional deficiencies in prehistoric contexts.

### The US ARMY Anthropometric Survey (ANSUR II): Database of body-size and associated demographic data of military personnel

JOSEPH L. PARHAM, TODD N. GARLIE, HYEK JOO CHOI, J. DAVID BRANTLEY and STEVEN P. PAQUETTE

Anthropology, US Army, Natick Soldier Research, Development & Engineering Center (NSRDEC)

The US Army Anthropometric Survey (ANSUR II) collected data on 8,120 males and 3,841 females at 12 Army bases in the United States, from which 4,082 males and 1,986 females were selected to make a final working database to represent the current U.S. Army population. A total of 93 directly-measured body dimensions were collected for each subject in this study, to include skeletal heights and breadths, as well as circumferences, measurements of the head, hands, and feet, functional measurements such as reaches, and some specific dimensions important to clothing/uniform or vehicle/workstation design. A further 41 measurements relevant to design were derived from those directly-measured. Inter-observer error for each measurement was carefully recorded during data collection to monitor performance of measurers, and to provide important context to future analyses. The database is representative of the US Army with a sampling strategy based on age, race/ethnicity, and with males and females treated separately. Detailed demographic data were collected for each subject and are reported with the anthropometric data. The ANSUR II data were collected to replace an earlier anthropometric survey (Gordon et al, 1989) and to serve the US Army's current design and engineering needs. These data also serve to inform industrial and commercial design of human-centered products, and are a unique resource to a wide variety of researchers concerned with human variation. Technical Reports describing the methods, summary statistics, and measurement techniques are readily available.

### Joint articulation in resolving commingled human remains: Osteometric analysis of the acetabulo-femoral and tibio-femoral articular surface areas

EÓIN W. PARKINSON<sup>1</sup> and ELIZABETH CRAIG-ATKINS<sup>2</sup>

<sup>1</sup>Department of Archaeology & Anthropology, University of Cambridge, <sup>2</sup>Department of Archaeology, The University of Sheffield

This research presents an innovative and objective method of partially resolving commingled remains through osteometric analysis of the acetabulo-femoral and tibio-femoral joint surface

areas. This method is focused on reassociating skeletal elements which can provide accurate information regarding age, sex and stature, thus maximising the potential of commingled remains in archaeological investigations. This study used linear dimensions to create geometric models, corroborated by 3D scanning, to estimate articular surface area. Data was collected from 13 observations from across the acetabulo-femoral and tibio-femoral joints using a reference sample of 301 English medieval skeletons from the York Barbican and Black Gate skeletal collections. Linear regression analysis was used to explore the relationship between the acetabulo-femoral and tibio-femoral joints and create regression models. The regression models were then tested on an independent sample of 49 individuals from the post-medieval Coronation Street Cemetery in a series of test applications to evaluate the performance of the method. The regression models have been provided for use in osteometric sorting. The study showed that the tibio-femoral joint was not an acceptable candidate for osteometric sorting through joint articulation, but that the strong correlation between the acetabulum and femur across the acetabulo-femoral joint could be used to aid in partially resolving commingled assemblages. The results also demonstrated that geometric models provide accurate estimations of joint surface area.

### Genetics of pigmentation in East Asia: The role of OCA2 polymorphisms

LIDA RAWOFI<sup>1</sup>, MELISSA EDWARDS<sup>1</sup>, S KRITHIKA<sup>1</sup>, NICOLE MURRAY<sup>1</sup>, HEATHER L. NORTON<sup>2</sup> and ESTEBAN J. PARRA<sup>1</sup>

<sup>1</sup>Anthropology, University of Toronto, <sup>2</sup>Anthropology, University of Cincinnati

Very few studies have been devoted to identify the genetic factors responsible for normal pigmentation variation in East Asian populations. The evidence available thus far indicates that the gene *OCA2* plays a major role in these populations. Two non-synonymous polymorphisms, rs1800414 and rs74653330, have been associated with pigmentary traits (skin pigmentation and iris colour) in East Asian populations. Interestingly, these two polymorphisms have very different geographic distributions: The derived rs1800414 G allele reaches very high frequencies in Japan, China and Korea, whereas the derived rs74653330 A allele is common in Altaic speaking populations from northern East Asia and Mongolia. Both polymorphisms are located in the same haplotype block, but are always found in different haplotypes. Overall, there is strong evidence indicating that the two polymorphisms arose independently and increased in frequency in different geographic regions within East Asia, possibly due to the action of positive selection. We recently carried out a genome-wide association study (GWAS) of pigmentary

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traits in a sample of individuals of East Asian ancestry living in Canada. Skin pigmentation and hair colour were measured using reflectance spectrometry and iris colour was extracted from high-resolution photographs and measured using the CIELab system. The samples were genotyped with an Illumina MEGA array. We confirmed the important role that the *OCA2* gene plays in determining pigmentation diversity in East Asia. We identified other genomic regions showing suggestive associations with skin pigmentation and iris colour and are currently replicating these signals in independent East Asian samples.

*This work was supported by an NSERC Discovery Grant to EJP and a US Department of Justice grant to HLN and EJP. LR has received an NSERC Masters Scholarship (CGS-M).*

### Documenting Burials and Mortuary Context in the Field using 3D Technology

TED PARSONS and RYAN P. HARROD

Department of Anthropology, University of Alaska Anchorage

Bioarchaeologists and forensic anthropologists strive to develop methods for maximizing the information that they decipher from human skeletal remains and their archaeological context. Traditional methods for recording burial and mortuary sites include 2D photo documentation and in situ illustration and mapping. While valuable, these techniques offer a limited means of reconstructing spatial context. Total stations and terrestrial laser scanners (TLS) have been used to digitally model features. There are inherent limitations to these technologies, however. The units are bulky and expensive, and can require considerable setup effort and time. The purpose of this paper is to explore other, more mobile, and time-efficient recording technologies. We field-tested two methods using three types of sensors. First, we utilized photo modeling, a form of passive sensing where ambient energy (light) is captured, and a commercial 3D software package called Agisoft PhotoScan. The second method was active sensing, where energy is both transmitted and received. Here we used repurposed Microsoft Kinect® videogame controllers as low-cost depth-mapping sensors. We tested both generations of Kinect devices, the V1 and V2, using several commercial and free software suites. We captured 3D models of two staged burials (both recently interred and freshly excavated), an adult female black bear, and a full-sized plastic human skeleton model. Results show that these techniques create photorealistic and precise 3D models that are very useful in thoroughly documenting burials and mortuary contexts. We conclude with a discussion of the benefits and limitations of each 3D method employed.

### Bulging Biceps: MicroCT Analysis of Enteseal Changes at Byzantine St. Stephen's Monastery, Jerusalem

ADAM C. PASQUINELLI<sup>1,2</sup>, KATHERINE A. PORTMAN<sup>1</sup>, SUSAN G. SHERIDAN<sup>1</sup> and MATTHEW J. RAVOSA<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Notre Dame, <sup>2</sup>Biological Sciences, University of Notre Dame

Twenty years of analyses of the skeletal and textual remains from St. Stephen's monastery has permitted the reconstruction of a bioarchaeological model of excessive genuflexion. Highly repetitive deep knee bends are suggested by the presence of squatting facets, musculoskeletal markers (MSMs), enthesopathies, and degenerative joint disease of the calcanei, tali, tibiae, fibulae, femora, and innominates of these men. This research has recently expanded to the upper limbs to test whether the monks were using an arm to rise from the 200-300 daily genuflexions described in liturgical texts. A preliminary study using the Coimbra method for macroscopic scoring assessed specimens representing eight fibrocartilaginous entheses on the humerus, ulna, radius, and clavicle (n=630) for a variety of pathological traits. Of 64 total features (8 each on 8 entheses), only two demonstrated a significant side difference. The biceps brachii insertion on the proximal radius (n=101) showed a notably high incidence of Zone 1 bone formation (38%), thereby prompting the current microstructure study. Forty randomly chosen radial tuberosities were examined using microscopic computed tomography (microCT) at insertion sites demonstrating macroscopic enteseal change. This microarchitecture analysis is part of a larger study of upper limb usage during genuflexion suggested by the lower limb biomechanical model. Thus, the use of 3D imaging on the microscopic level has the potential to drastically increase the sensitivity and scope of activity reconstruction in humans as well as other primates.

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### Experiences in the application and attendance of human skeletal biology graduate programs

NICHOLAS V. PASSALACQUA<sup>1</sup> and HEATHER M. GARVIN<sup>2</sup>

<sup>1</sup>Anthropology and Sociology Dept, Western Carolina University, <sup>2</sup>Department of Applied Forensic Sciences and Department of Anthropology/Archaeology, Mercyhurst University

In 2016 an electronic survey was sent to various listservs soliciting participation from current and former students in human skeletal biology graduate programs. The anonymous survey collected information regarding experiences applying to and

attending graduate school, as well as faculty opinions on applicant qualities. The aim of collecting and presenting these data are to: i) assess past trends and current state of the academic field; and ii) provide information to future students to better prepare them for success in their human skeletal biology careers. The responses of more than 230 questionnaires were analyzed. Our results indicate that the majority of respondents (~51%) obtained an undergraduate degree from a four-field anthropology program. The average undergraduate GPA was a 3.6, regardless of the highest degree obtained by the respondent; and the average overall GRE score was 312. Approximately 61% took time off either before or between graduate degrees, and the majority of respondents recommended taking time off, with the caveat that individuals must stay active in the field during the break. Thirty percent of respondents had full funding for their masters and 66% for their doctorate. Of the 96 respondents that have already completed their PhD, the average time to completion was 6.3 years. From faculty currently accepting graduate students, the average *minimum* GPA considered for acceptance into graduate programs is ~3.3 (responses ranged from 3.0 to 3.8), and 46% of respondent faculty indicated they had a preferred *minimum* GRE score for acceptance (scores ranged from 300 to 320).

### New fossils and the paleobiology of *Karanisia clarki* from the late Eocene of Egypt

BIREN A. PATEL<sup>1,2</sup>, DOUG M. BOYER<sup>3</sup>, BERNADETTE A. PERCHALSKI<sup>3</sup>, TIMOTHY M. RYAN<sup>4,5</sup>, ELIZABETH M. ST. CLAIR<sup>6</sup>, JULIA M. WINCHESTER<sup>3,7</sup> and ERIK R. SEIFFERT<sup>1</sup>

<sup>1</sup>Cell and Neurobiology, Keck School of Medicine, University of Southern California, <sup>2</sup>Human and Evolutionary Biology, University of Southern California, <sup>3</sup>Evolutionary Anthropology, Duke University, <sup>4</sup>Anthropology, Pennsylvania State University, <sup>5</sup>Center for Quantitative X-Ray Imaging, EMS Energy Institute, Pennsylvania State University, <sup>6</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>7</sup>IDPAS, Stony Brook University

The fossil strepsirrhine *Karanisia*, known from late Eocene sites in Egypt and Libya, was first described on the basis of partial mandibles and isolated upper and lower teeth. Phylogenetic analyses that have incorporated character data from these dental remains have placed *Karanisia* either within crown Lorisidae, as a stem loriform, or as an advanced stem strepsirrhine. In this study we describe new material from the Fayum Locality BQ-2 that includes teeth and a fragmentary maxilla of *Karanisia clarki*, as well as several postcranial bones (distal humerus, proximal femur, calcaneus, first metatarsal) that are likely attributable to this species. The maxilla has a very shallow suborbital floor and the roots of

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the upper second molar are exposed in the orbit. Dental topographic analysis of lower second molars across a broad sample of euarchontans suggests that *Karanisia* had an omnivorous diet. The distal humerus has a globular capitulum, distinct zona conoidea, shallow olecranon fossa, and narrow brachioradialis flange. The proximal femur lacks features that are common to small "prosimian" leapers, including the specialized femoral head morphology that is seen in late Eocene *Wadilemur* and Miocene-Recent galagids. The distal end of the calcaneus is abraded, but the body and tuber are somewhat loris-like in being dorsoplantally and mediolaterally bowed. The first metatarsal has a loris-like proximal articular surface and peroneal process, but the distal end lacks specializations seen in crown lorises. *Karanisia* appears to have had a fairly generalized postcranial skeleton, and was possibly a cautious arboreal quadruped with no obvious leaping proclivity.

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## Comparative performance of deciduous and permanent dental morphology in reconstructing biological kinship

KATHLEEN S. PAUL and CHRISTOPHER M. STOJANOWSKI

Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University

Dental phenotypic data play an important role in reconstructing biological relationships in the past. Permanent crown morphology is used most often; deciduous morphology is less utilized due to a lack of pedigree-based research focused on primary characters. This is unfortunate, as researchers have hypothesized that deciduous phenotypes provide a faithful reflection of underlying genotypic information because their rapid *in utero* development provides an "environmental buffer" during crown formation. Here, we test this hypothesis by conducting intra-individual comparisons of the performance of deciduous and permanent morphological data sets for reconstructing documented genealogical relationships. We recorded crown trait expression for deciduous and permanent dental casts of 66 Burlington Growth Study participants housed at the University of Toronto Faculty of Dentistry. Following a simulated bioarchaeological approach, 20 deciduous and 22 permanent morphological traits were used to generate 69 inter-relative and 2040 non-relative Euclidean distances for each data set; distance ordination was performed via multidimensional scaling. Results show average inter-relative distance to fall significantly below the average of 69 resampled pseudo-distances generated from 9,999 replicates of non-relative pairs for both the

deciduous data set ( $d=0.252$ ,  $p<0.001$ ) and the permanent data set ( $d=0.321$ ,  $p<0.001$ ). Using the same criteria to evaluate family-specific performance, the deciduous data set outperformed the permanent data set at a rate of 2:1. Furthermore, over 70% of the families exhibited greater dispersion across multidimensional space when represented by permanent morphology. Results suggest that deciduous crown characters provide a more direct reflection of small-scale biological relationships than does permanent morphology.

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## Building Communities: Strontium isotope and cross-sectional geometry analysis in early sedentary communities

JESSICA A. PEARSON<sup>1</sup>, DOUGLAS BAIRD<sup>1</sup>, JANE EVANS<sup>2</sup>, EVAN GAROFALO<sup>3</sup>, CHRISTOPHER B. RUFF<sup>4</sup>, SCOTT D. HADDOW<sup>5</sup>, CHRISTOPHER J. KNÜSEL<sup>5</sup> and CLARK S. LARSEN<sup>6</sup>

<sup>1</sup>Archaeology, Classics and Egyptology, University of Liverpool, <sup>2</sup>NERC Isotope Geosciences Laboratory, British Geological Society, <sup>3</sup>School of Life Sciences, Arizona State University, <sup>4</sup>Center for Functional Anatomy & Evolution, School of Medicine, Johns Hopkins University, <sup>5</sup>PACEA, UMR 5199, Université de Bordeaux, <sup>6</sup>Department of Anthropology, The Ohio State University

Twelve thousand years ago, mobile hunter-gatherers of the Near East gradually adopted sedentarizing behaviors living in communities of 10s-100s for much of the year in settlements that rarely measured more than a few hectares. Approximately 9000 years ago many of these settlements disappeared and were replaced by a few large villages, which spanned up to 20 hectares and housed up to 8000 people. These mega-sites were the first of their kind. Living in larger communities requires some degree of transition from residential to logistical mobility and negates the need to exchange partners (often females) with outside communities. We address this hypothesis by combining strontium and oxygen isotope analysis ( $n=25$ ) and long bone mechanical properties ( $n=70$ ) at two sites less than 10km apart in Neolithic Anatolia: a small hunter-gatherer site Boncuklu and the later agro-pastoral mega-site Çatalhöyük. These isotope data, measured on male and female permanent M2 teeth, suggest that all of the Boncuklu inhabitants spent their childhood in the local area. For the analysis of long bone mechanical properties the ratio of AP and ML bending strength ( $Zx/Zy$ ) was taken at femoral mid-shaft for male and female adults from early ( $n=5$ ), middle ( $n=54$ ), and late ( $n=11$ ) occupation levels. These data indicate that mobility increased in both sexes and significantly so among females from early to late occupation levels (Kruskal

Wallis  $H=7.3$ ;  $p<0.03$ ). These data indicate a divergence from what was expected suggesting that mobility in early residential communities may be much more complex than previously suggested.

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## Fluidity of "Color" among Brazilians Investigated using Genomic Ancestry, Skin Pigmentation, and Facial Ancestry

LAUREL N. PEARSON<sup>1</sup>, DIEGO A. HERNANDEZ<sup>1</sup>, PETER CLAES<sup>2</sup>, RINALDO W. PEREIRA<sup>3</sup> and MARK D. SHRIVER<sup>1</sup>

<sup>1</sup>Anthropology, Pennsylvania State University, <sup>2</sup>ESAT/PSI - UZ Leuven, iMinds, Medical IT Department, KU Leuven, <sup>3</sup>Programa de Pós-Graduação em Ciências Genômicas e Biotecnologia, Universidade Católica de Brasília

Several centuries of admixture in Brazil has resulted in a population that is highly heterogeneous. Previous studies have suggested that genomic ancestry is not a good predictor of an individual's self-reported "Color". Using genomic ancestry, phenotypic measures of pigmentation and facial ancestry, and self-reported "Color" of first and second degree relatives (parents and grandparents), we investigate how these factors may influence self-classification.

Research volunteers recruited in Brasilia, Brazil completed demographic questionnaires that included information on self-reported ancestry ("Color") as well as participated in phenotype collections that included facial photographs, skin pigmentation measures, and sampling of saliva and finger-stick blood for DNA extraction. Genomic ancestry was estimated in a three-way model of admixture (European, West African, and Amerindian) using genotypes from a panel of ancestry informative markers.

Pigmentation is found to be correlated with West African genomic ancestry ( $r = 0.20$ ,  $p < 0.0001$ ) in this study population. Individuals who self-identified as Branca/White, Parda/Brown, and Preta/Black were found, however, to have overlapping distributions of West African genomic ancestry and constitutive skin pigmentation with mean ancestry being significantly different between "Color" groups. Interestingly, mean skin pigmentation is more significantly different between groups than ancestry. Additionally, results of facial ancestry modeled from three dimensional photographs compared to both genomic ancestry and self-reported "Color" will be reported. Our findings support the idea that phenotype plays an important role in self-classification of "Color" in Brazil.

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### Variation among inferred habitual activity in Upper Pleistocene modern humans

OSBJORN M. PEARSON<sup>1</sup>, ETHAN C. HILL<sup>1</sup> and VITALE S. SPARACELLO<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of New Mexico, <sup>2</sup>UMR5199 PACEA, Université de Bordeaux

To gain insights into the habitual activities of Upper Pleistocene modern humans, we compare strength and shape variables for the midshafts of the femur, tibia, humerus, radius, and ulna of a series of Upper Paleolithic humans and a set of 12 Holocene comparative samples. Upper and lower limb data were analyzed separately and the data subdivided by sex. Limb bone data consist of body-size-standardized values for the polar section moduli (Z) and ratios of external maximum to minimum diameters. Standardization for body size was performed by dividing each Z by the product of estimated body mass and bone length. Results for the lower limb largely reiterate the well-known conclusions that Pleistocene populations were highly mobile and had comparatively strong femora and tibiae. Neandertal males and females, Qafzeh 9, Gravettian females, and Epigravettian males have much higher femoral size-adjusted Z than Holocene populations. Values for tibial adjusted Z are less striking. Gravettian males show a remarkably wide range of femoral midshaft shapes. Upper limb data produced more complicated and varied patterns. In the pooled sample, adjusted-Z values for the humerus, radius, and ulna are moderately correlated ( $0.61 < r < 0.64$ ), but Neandertal males have strong humeri coupled with weak forearms. Neandertal values for humeral adjusted Z are high but matched by Australian, Sami, and Mesolithic males. The Pleistocene samples show marked variation in humeral midshaft shape, but almost all have low indices for radial and ulnar shape.

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### Navigating peaks of speciation and extinction: Did prime movers or random effects lead to the composition of the South African fossil record?

DANIEL C. PEART and JEFFREY MCKEE

Department of Anthropology, The Ohio State University

The fossil record of the Pliocene and Pleistocene is notoriously incomplete, leading to misinterpretation and speculation regarding the speciation and extinction in prehistoric Africa. During the last five million years, speciation events, when multiple species appear in the fossil record, and extinction events, when several species disappear from the fossil record during a short evolutionary time span, occur only a few times. These events may be indicative of large turnover

events; however, these same peaks of species turnover may happen by chance. A computer program was developed to simulate evolution of species, and the creation of a random fossil record. Peaks of speciation and extinction occur randomly in all simulations, and the frequency of these peaks is statistically similar to the peaks observed in the fossil record for Africa during the Pliocene and Pleistocene. This project supports the null hypothesis that the fossil record was generated randomly and is not the product of large-scale climatic shifts leading to extensive species turnover.

### Treponemal Disease in Early China

KATE PECHENKINA<sup>1</sup>, SONGTAO CHEN<sup>2</sup> and WENQUAN FAN<sup>3</sup>

<sup>1</sup>Anthropology, Queens College, CUNY, <sup>2</sup>Archaeology, Shandong University, <sup>3</sup>Archaeology, Henan Provincial Institute of Cultural Relics and Archaeology

The timing and manner of the spread of pathogenic treponemes into East Asia is poorly understood. A few early cases that have been described were diagnosed based on the examination of fragmentary remains, some with no clear archaeological context. Cranial lesions consistent with treponematosis were described on an isolated skull from Fujiang Province dated to the Song dynasty (AD 960–1279). Possible cases of treponematosis have been diagnosed by Suzuki from postcrania recovered at Kayue culture sites (500 BC–AD 150) located in Qinghai Province. The paucity of data on early treponematosis makes it difficult to reconstruct the history of treponemal disease in the region. We have examined multiple skeletal collections from China's Central Plain that range in time from the Middle Neolithic to Bronze. Six out of 74 skeletons from the Tiancheng cemetery site, dating to between 770–221 BC, located south of the Zheng Han city wall, displayed severe periosteal lesions affecting tibiae, fibulae, and distal femora bilaterally. Additional possible cases of treponematosis were found within the Zheng Han city limits, in the Changxinyuan and Shuanglou cemeteries. Although precise diagnosis of treponematosis is complicated, given that all affected individuals were adult males, a sexual route of transmission cannot be dismissed. Together these cases present strong evidence that pathogenic treponemes were posing health problems on China's Central Plain by the time of the Eastern Zhou dynasty. No convincing cases of treponemal disease were found in individuals excavated from Neolithic sites, suggesting that pathogenic treponemes entered the region after 2000 BC.

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### Photogrammetric Imaging: A Fresh Look at the Laetoli Hominin Footprints in Relation to Recent Discoveries

ALEX J. PELISSERO<sup>1</sup>, CHARLES M. MUSIBA<sup>1</sup>, FIDELIS MASAO<sup>2</sup>, AUDAX MABULLA<sup>3</sup>, CASSIAN MAGORI<sup>4</sup>, ELIWASA MARO<sup>5</sup>, AGNES GIDNA<sup>3</sup>, HENRY T. BUNN<sup>5</sup>, ALIA GURTOV<sup>5</sup>, AKSHAY SARATHI<sup>5</sup>, JINGSHU LI<sup>5</sup>, GODFREY OLE MOITA<sup>6</sup>, MARGARET KAISOE<sup>6</sup>, JACKSON WASHA<sup>3</sup>, JESUIT TEMBA<sup>6</sup>, SAID KILLINDO<sup>2</sup>, JOHN PARESSO<sup>6</sup>, ANDREW LOWASSA<sup>7</sup> and JOSHUA MWANKUNDA<sup>7</sup>

<sup>1</sup>Dept. of Anthropology, University of Colorado, Denver, <sup>2</sup>Dept. of Archaeology, University of Dar-es-Salaam, <sup>3</sup>N/A, National Museum of Tanzania, Dar-es-Salaam, <sup>4</sup>Dept. of Anatomy, St. Francis University College of Health and Allied Sciences, <sup>5</sup>Dept. of Anthropology, University of Wisconsin, Madison, <sup>6</sup>Antiquities Division, Ministry of Natural Resources and Tourism, Tanzania, <sup>7</sup>N/A, Ngorongoro Conservation Area Authority

The 3.6ma Laetoli hominin trackway has long been recognized for its crucial importance in understanding the evolution of upright posture and bipedalism in hominins. This ichnofossil record has also provided a snapshot of the paleoecological settings in which the Pliocene hominins at Laetoli thrived. Continuing advances in imaging technology, particularly photogrammetry, offer great potential for detailed ichnofossil analyses, not only on how many individuals left the prints, but also the depositional environments and paleofaunal communities. The recent discovery of additional hominin and animal trackways southwest of the Site G hominin footprints provides a critical comparative data set to test hypotheses about Pliocene hominin locomotion and ichnotaxonomy. If the trackways demonstrate significant morphological and locomotor differences, it would suggest either that more than one hominin taxa inhabited the Laetoli Pliocene paleolandscape, or a great degree of variation among a single taxon. Utilizing digital photogrammetry, we conducted a comparative analysis on a portion of the newly discovered hominin trackway (M9) and the original Site G prints. Photographic and anthropometric measurement data were collected both directly from the trackways themselves and from the first generation cast of the Site G trackway housed at the Laetoli visitor's center. Focusing on the morphological characteristics of the footprints, gait patterns, and the taphonomic context of the trackways, here we present some preliminary results, which strongly indicate striking similarities and differences between the two sets; where the newly discovered tracks anthropometric and photogrammetry-based print morphology fall within the normal ranges of human pedal and footprint morphology.

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## Revised geochronology of the Early Miocene faunas from Rusinga Island and Mfangano Island (Lake Victoria, Kenya): Implications for Miocene hominoid evolution and faunal succession

DANIEL J. PEPPE<sup>1</sup>, ALAN L. DEINO<sup>2</sup>, KIERAN P. MCNULTY<sup>3</sup>, MARK S. MCCOLLUM<sup>1</sup>, ALEXANDRA L. MITCHELL<sup>4</sup>, STEVEN G. DRIESE<sup>1</sup>, HOLLY M. DUNSWORTH<sup>5</sup>, DAVID L. FOX<sup>6</sup>, WILLIAM E.H. HARCOURT-SMITH<sup>10,7,8,9</sup>, KIRSTEN JENKINS<sup>3</sup>, THOMAS LEHMANN<sup>11</sup> and LAUREN A. MICHEL<sup>1,12</sup>

<sup>1</sup>Terrestrial Paleoclimatology Research Group, Department of Geosciences, Baylor University, <sup>2</sup>Berkeley Geochronology Center, <sup>3</sup>Department of Anthropology, University of Minnesota, <sup>4</sup>Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, <sup>5</sup>Department of Sociology and Anthropology, University of Rhode Island, <sup>6</sup>Department of Geology and Geophysics, University of Minnesota, <sup>7</sup>Department of Anthropology, Lehman College CUNY, <sup>8</sup>Department of Anthropology, Graduate Center CUNY, <sup>9</sup>Division of Paleontology, American Museum of Natural History, <sup>10</sup>NYCEP, <sup>11</sup>Senckenberg Research Institute and Natural History Museum Frankfurt, <sup>12</sup>Department of Earth Sciences, Tennessee Technological University

Early Miocene faunas from Rusinga and Mfangano Islands (Lake Victoria, Kenya) provide critical evidence for understanding early hominoid evolution and faunal succession in East Africa. However, the utility of these faunas depends on accurate determination of their ages. Almost all fossils collected on these islands come from the Rusinga Group, which is sub-divided (in ascending stratigraphic order) into the Wayando, Kiahera, Rusinga Agglomerate, Hiwegi, and Kulu Formations. Here we report new geochronological results for the fossiliferous deposits on Rusinga and Mfangano.

<sup>40</sup>Ar/<sup>39</sup>Ar incremental heating analyses of biotite from the Wayando, Kiahera, Rusinga Agglomerate, and Hiwegi Formations, and paleomagnetism analyses through the Rusinga Group indicate that all of the fossiliferous deposits on Rusinga and Mfangano were deposited between ~17 and ~20 Ma. Additionally, detailed paleomagnetism analysis through the fossil-bearing Hiwegi Formation demonstrates that it samples two different environments that are temporally distinct. These results indicate that the Rusinga Group deposits are older and represent a wider time-range than previously suggested and that historical collections from the Hiwegi Formation are time-averaged assemblages derived from multiple environments. Furthermore, these results demonstrate that the Rusinga and Mfangano faunas are penecontemporaneous with other early Miocene fossil sites traditionally considered older (e.g., Songhor, Koru, Napak, Bukwa) and younger (e.g., Kalodir, Moruorot). Thus, taxonomic differences between early Miocene faunas across eastern Africa are related to paleoenvironmental differences between the sites, taphonomic biases, variability

in the biogeographic ranges of the fauna, and/or relatively rapid faunal turnover in the early Miocene.

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## Regional Variation of Dental Microwear in the English Late Bronze Age and Iron Age

ROSE L. PERASH

Department of Anthropology, University of Indianapolis

The Late Bronze Age and Iron Age in England are marked by a change in the scale and complexity of various technologies, including those used for food processing. Dental microwear texture analysis (DMTA) provides a means of quantifying the hardness and toughness of consumed foods by examining the microscopic features found on Phase II facets of molar occlusal surfaces. DMTA has been used to determine different microwear trends in the North and South of England for Early Bronze Age groups. However, the extent to which food technologies and subsistence strategies varied regionally in the Late Bronze Age and Iron Age and how this subsequently impacted dental microwear is not well known.

Dental molds were taken from the Northern East Yorkshire collection (N= 8) and various Southern sites (N=20). High-resolution casts were examined under a white light confocal profiler following standard DMTA procedures. Toothfrac© and Sfrax© software were used to compute complexity (Asfc), anisotropy (epLsar), scale of maximum complexity (Smc), and textural fill volume (Tfv) values. Analysis of variance was performed and a statistically significant difference was found for the Asfc values of the Northern and Southern groups ( $p = .006$ ), with the Northern group having a far harder diet than that of the Southern group (Asfc values of 2.60 and 1.45, respectively). In this case, it appears that the Northern Late Bronze Age and Iron Age continued a dependence on harder foods (such as those consumed in the Early Bronze Age), in comparison to contemporaries in the south.

## Modifying Descent Behaviors in Response to Support Steepness in Primates

BERNADETTE A. PERCHALSKI

Evolutionary Anthropology, Duke University

Primates retain many characteristics hypothesized to have been selected for in a small, agile arboreal ancestor. These features, such as relatively long hind limbs and claw loss, introduce mechanical challenges for moving headfirst down through an arboreal environment that may increase as body mass increases. Five arboreal strepsirrhine species (*Daubentonia madagascariensis*, *Eulemur coronatus*, *Microcebus murienus*,

*Nycticebus pygmaeus*, and *Varecia vareigata*;  $n = 18$ ) were filmed at 60 to 120 frames per second moving at self-selected speeds across a body size scaled support set at four orientations: horizontal, 30°, 60°, and vertical. It was predicted that having high or posteriorly concentrated body mass would make moving headfirst on steep supports challenging, prompting behavioral shifts to reduce mechanical difficulties including forward pitch, high support reaction forces on the forelimb, and decreased passive friction. All species reduced frequency of headfirst travel as support steepness increased. Species with high intermembral indices (*Varecia*, *Nycticebus*, *Microcebus*) used similar frequencies of head-first descents, while species with the relatively longest hind limbs (*Eulemur*) and specialized gracile manual digits (*Daubentonia*) avoided this behavior on steeper supports. Behavior was strongly correlated with age in larger species (*Daubentonia*, *Eulemur*, *Varecia*), with older (aged 10+ years) individuals exclusively using tail-first descent of the vertical pole, while younger individuals showed greater behavioral flexibility. Kinematic changes to gait and posture were also compared. This research found behavioral modifications to descent related to morphology and age, which could have been evolutionarily important as primates underwent selection for increased body mass and extended life histories.

*This research was funded by the Duke Lemur Center and by the Duke University Department of Evolutionary Anthropology*

## Estimating ancestry of patients from the Colorado State Insane Asylum from 1879-1899 using geometric morphometric software

ROSA PEREZ<sup>1</sup> and ANN H. ROSS<sup>2</sup>

<sup>1</sup>Department of Sociology and Anthropology, North Carolina State University, <sup>2</sup>Department of Biological Sciences, North Carolina State University

The purpose of this research is to estimate ancestry for the exhumed remains from the 19<sup>th</sup> century Colorado State Insane Asylum paupers' cemetery in Pueblo, Colorado. These remains are unique in that the historical documents suggest that they were individuals who were poor or unwanted and were left to be buried in the asylum cemetery. This project focuses specifically on using the software 3D-ID Geometric Morphometric Classification of Crania for Forensic Scientists developed by Ross and Slice (2014) to estimate ancestry. Standard anatomical landmarks were collected on 48 individuals from the cemetery. Previous research suggests that the individuals buried within the asylum cemetery were of European ancestry. However, of the sample of 48 used in this research, 12.5 percent (probabilities: typicality = 0.326 – 0.971; posterior = 0.325 – 0.992) were found to be of South American or Mesoamerican ancestry,

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and 10.4 percent (probabilities: typicality = 0.377 – 0.933; posterior = 0.651 – 0.975) were found to be of African American ancestry. In addition to previous research conducted on the demographics of 19<sup>th</sup> century Pueblo, Colorado, further historical research on immigration and marginalization of the period allows for a greater context of the asylum population and those deemed insane in frontier Colorado.

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### Minority Rules: Social Capital, Scientific Obligations, and the Struggle to Decolonize Biological Anthropology

VENTURA R. PÉREZ

Anthropology, University of Massachusetts Amherst

For minority researchers, the role of systemic violence is not merely a part of what we study; it is a part of what we live. The inclusion of under-represented groups in the field of biological anthropology and the American Association of Physical Anthropologists has led to a shift in our epistemological frameworks and pedagogical approaches, yet the level of engagement and the expectations placed on minority scholars comes with a hidden burden and an unrealistic set of expectations. Biological anthropology has failed when it comes to decolonizing our own practices. Works by minority scholars and our role in theory building are not reflected in the canon of the discipline.

This paper explores these concepts through the lens of violence theory using the repatriation of the 1902 Yaqui massacre victims ( $n=13$ ) collected that year by Aleš Hrdlička in Sonora, Mexico. Hrdlička, along with his publications and those of the US and Mexican press, normalized the cultural and structural violence being perpetrated against the Yaqui both in the past and present.

The “rules” for minority researchers and academics come with obligations that are bound to the social capital of our positionality. It is not merely the impact ethnicity, culture, and gender have on an individual's career that is at play. Rather, the onerous burden is that members of disenfranchised groups have to “represent.” This is because minority scholars/teachers know they are often best situated to counter negative stereotypes and to serve as role models, mentors, or cultural translators for disenfranchised groups.

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### Covariation in life history, body and brain size, and molecular substitution rate across the diverse radiation of extant and extinct (megafaunal) lemurs

GEORGE PERRY<sup>1,2</sup>, LOGAN KISTLER<sup>1,3</sup>, GARY T. SCHWARTZ<sup>4</sup>, LAURIE R. GODFREY<sup>5</sup> and LUDOVIC ORLANDO<sup>6</sup>

<sup>1</sup>Department of Anthropology, Penn State University, <sup>2</sup>Department of Biology, Penn State

University, <sup>3</sup>School of Life Sciences, University of Warwick, <sup>4</sup>School of Human Evolution and Social Change, Arizona State University, <sup>5</sup>Department of Anthropology, University of Massachusetts, <sup>6</sup>Centre for GeoGenetics, University of Copenhagen

Among primates, molecular substitution rates are significantly negatively correlated with brain and body size, likely reflecting strong relationships between brain/body size and life history variables – especially generation time – that affect the accumulation of nucleotide substitutions per unit time. Previous research revealed a decoupling of body size and life history (dental microstructure indicators of gestation length, weaning age, interbirth interval) for the giant, extinct “subfossil” lemurs of Madagascar. Here we evaluated substitution rate, brain and body size, and life history variables among 17 lemur species, including three extinct subfossil taxa for which we have generated high-quality complete mitochondrial DNA (mtDNA) genome sequences from ancient DNA. Among the 14 extant lemurs, encephalization and molecular substitution rate were significantly negatively correlated ( $r^2=0.29$ ;  $P<0.05$ ). However, the extinct taxa do not fit this pattern; among all 17 species encephalization explains very little substitution rate variance ( $r^2=0.06$ ;  $P=0.36$ ). We discuss two non-mutually exclusive explanations for this result. One, our substitution rates reflect the entire length of each branch from the extant/recently-extinct lemur back to their common ancestor with the closest evolutionary relative in our phylogeny, while the morphological and life history variables we analyzed represent branch endpoints. Thus, extinct subfossil lemur morphology and life history may be relatively unrepresentative of the majority of the evolutionary histories for their respective branches. Two, mtDNA substitution rates may not be suitable for this analysis. Substitution rates obtained from multiple independent loci across the much larger nuclear genome would be less stochastic and may provide a different result.

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### Reconstructing Székely Subsistence: Stable Isotope Evidence for Medieval Diet in Eastern Transylvania

EMILY M. PESCHEL<sup>1</sup>, TYLER E. DUNN<sup>2</sup>, JONATHAN D. BETHARD<sup>3</sup>, ZSOLT NYARADI<sup>4</sup>, ANDRE GONCIAR<sup>5</sup>, M. ANNE KATZENBERG<sup>1</sup> and STANLEY H. AMBROSE<sup>2</sup>

<sup>1</sup>Anthropology and Archaeology, University of Calgary, <sup>2</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>3</sup>Anthropology, University of South Florida, <sup>4</sup>Archaeology, Haáz Rezső Múzeum, <sup>5</sup>Archaeology, Archaetok

Bioarchaeologists have contributed a great deal to what is known about the diet of medieval Europeans; however, few studies have investigated subsistence choices of Hungarian-speaking Székely communities who have lived

in the eastern Carpathian Basin of Transylvania for centuries. This study utilizes dental tissues of individuals recovered from the medieval Christian churchyard in the Székely village of Bögöz. Salvage excavations conducted in 2012 and 2013 yielded nearly 200 human burials as the church and surrounding churchyard was utilized as part of the Székely mortuary program from the 12th to 19th centuries. This preliminary investigation into Székely diet utilizes stable carbon and nitrogen isotope values measured from dental tissues from 38 individuals. Based on the initial analysis of ten teeth, apatite carbon isotopes show a largely C3 plant diet with approximately  $30 \pm 6\%$  of their diet coming from C4 plants, likely *Setaria italica* (foxtail millet), which has been a dietary staple since the Bronze Age in central Europe. Collagen  $\delta^{13}C$  values provide an estimated  $20 \pm 6\%$  C4, which indicates that most of the dietary protein came from C3-fed animals. The low average  $\delta^{15}N$  ( $10.7 \pm 0.8\%$ ) suggests a predominantly plant-based diet. Lastly, there were no differences in  $\delta^{15}N$  values from person to person. Therefore, it can also be inferred that there was no dietary stratification in this small Székely population.

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### Modeling dietary variability in Middle Period San Pedro de Atacama, northern Chile

WILLIAM J. PESTLE<sup>1</sup>, CHRISTINA TORRES-ROUFF<sup>2,4</sup> and MARK HUBBE<sup>3,4</sup>

<sup>1</sup>Department of Anthropology, University of Miami, <sup>2</sup>Anthropology, School of Social Sciences, Humanities and Arts, University of California, Merced, <sup>3</sup>Department of Anthropology, Ohio State University, <sup>4</sup>Instituto de Arqueología y Antropología, Universidad Católica del Norte.

The Middle Period (AD400-1000) in San Pedro de Atacama, Chile, has been characterized as a time of peace, uniform abundance, and widespread access to exotic materials. In contrast, the transition from the Middle Period to the subsequent Late Intermediate Period (AD1000-1450), is understood to have brought major changes to the lifeways of the region's peoples; as far-flung networks of exchange and interaction broke down, social stressors and conflict increased. In this work, we critically examine both of these characterizations through the Bayesian mixture modeling of stable isotope data from  $n=265$  individuals representing twelve distinct cemeteries and five oases/*ayllus* in the area of San Pedro. This work reveals otherwise unobtainable insights into the individual dimensions of life, diet, and health in a changing and complex world.

First, based on patterns of inter- and intra-*ayllu* dietary variation, we argue that the benefits of participation in the Middle Period's systems of regional exchange were unevenly distributed, such that certain *ayllus* were more strongly involved, and that certain individuals within *ayllus*

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reaped more of the benefits of that trade and the concomitant prosperity than others. Second, our research shows that the broad social changes between the Middle and Late Intermediate Period had a significant impact on dietary composition. This shift was related not only to access to meat, as previously suggested, but also strongly tied to access to maize products, which may have been used to reinforce social status and gender inequalities during the Middle Horizon.

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### Dental microwear textures of *Paranthropus robustus* from Kromdraai, Drimolen, and an enlarged sample from Swartkrans

ALEXANDRIA S. PETERSON<sup>1</sup>, FREDERICK E. GRINE<sup>2</sup>, MARK F. TEAFORD<sup>3</sup> and PETER S. UNGAR<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Arkansas, <sup>2</sup>Department of Anthropology, Stony Brook University, <sup>3</sup>Department of Basic Science, Touro University

Dental microwear studies have suggested dietary differences between *Paranthropus robustus* and *P. boisei* despite similarities in their cranio-dental morphologies. *Paranthropus boisei* molar wear is indicative of the consumption of tough foods, such as grasses, whereas the microwear textures exhibited by *P. robustus* are consistent with at least occasional hard-object feeding. These differences are consonant with stable isotope studies that indicate a predominantly C<sub>4</sub> diet for the former and a mixed C<sub>3</sub>-C<sub>4</sub> diet for the latter. That said, the microwear sample of *P. robustus* employed to date is small ( $n = 9$ ) and largely restricted to molars from the Hanging Remnant of Swartkrans Member 1 (SK 1HR). This has made it difficult to interpret dispersion of microwear texture values, and hence dietary variability within this species. Here we present new data for *P. robustus* permanent molars that more than quadruple the sample ( $n = 42$ ) with additional specimens from various stratigraphic units at Swartkrans, and from Kromdraai and Drimolen. Results confirm the extreme range of complexity values for *P. robustus* as compared with *P. boisei*, but also reveal variation both within and between sites in South Africa. The SK 1HR molars evince a relatively high complexity average compared with specimens from other stratigraphic units at Swartkrans. Also, the dispersion of anisotropy values for the Drimolen sample extends the range for the species. These results suggest, with caveats for limited sample sizes, possible dietary and paleoecological differences among the various South African *P. robustus* samples that warrant further consideration using other proxies.

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### Individual Social Strategies Vary in Relation to Network Position Among Sub-Adult Male Long-Tailed Macaques

JEFFREY V. PETERSON and AGUSTIN FUENTES  
Department of Anthropology, University of Notre Dame

Intraspecific variation in primate social behavior sheds light on the causes and contexts of primate behavioral flexibility. Primates make use of cognitive and behavioral flexibility as they become socialized. This study compares the social strategies employed by sub-adult male long-tailed macaques (*Macaca fascicularis*) within and between two allopatric long-tailed macaque groups at Padangtegal and Uluwatu, Bali, Indonesia. The Padangtegal group has a larger population size (109 vs 80), greater population density (30.5 vs 17.7 ind/ha), more female skewed adult sex ratios (0.289 vs .667), and variable dispersal patterns. We collected 54 hours of behavioral observations on eight sub-adult males, four per site, yielding a data set of 970 behavioral interactions. We classified these interactions into four categories: affiliative, agonistic, submissive and neutral. Significant differences in interaction type frequency were found between sub-adult male individuals at Padangtegal ( $X^2 = 36.470$ ,  $df = 9$ ,  $p < 0.001$ ) and Uluwatu ( $X^2 = 80.839$ ,  $df = 9$ ,  $p < 0.001$ ). Notably, at both sites the individual with the fewest relative social interactions (71 compared to Padangtegal cohort mean 122; 105 compared to Uluwatu cohort mean 143) was the most centrally located in their respective proximity network. In other words, the focal animals at each site surrounded by more sub-adult male neighbors in close proximity (within 3 meters) during behavioral scans were less likely to interact with other group members. Thus, we argue that spatial proximity itself is an essential communicative act shaping group social landscapes.

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### Brain Size as an Evolutionary Constraint on Facial Form

ALESHA PETTIT and BRIAN VILLMOARE  
Anthropology, University of Nevada Las Vegas

Researchers have identified the neurocranium of the skull as a likely evolutionary module (e.g. Bastir, 2008, Enlow and Hans 1996; McCarthy and Lieberman 2001, Ross and Ravosa, 1993; Lieberman et al., 2000, 2008;) and have proposed that, as a module, it is independent relative to other proposed modules, including the face and basicranium. One implication of this is that the evolution of the brain and face impose no constraints on each other, so that selection on any one module is relatively unconstrained by the other functional modules of the cranium. However, Marcucio et al (2011) have proposed

that the brain imposes a significant influence on craniofacial development especially during development.

Although measures of modularity for the endocranium are useful, they are approximations of measures of the brain. Here, we seek to identify if brain size itself is independent, or constrained relative to the face and basicranium, optimistic that these results can inform how selection for encephalization in early hominins might have influenced overall cranial form. Cranial capacity data and landmarks were collected from 60 gorillas and 45 chimpanzees of mixed sex to identify how craniofacial variation patterned with brain size. CT scans from the Smithsonian great ape collection were used.

Results indicate that cranial capacity is remarkably independent of the rest of the cranium. From this, we infer that the face and the brain are able to respond relatively easily to independent selection vectors, and that any constraint on brain evolution comes from aspects inherent to the brain itself.

### Paleoenvironmental Reconstruction of the Koanaka Hills Pleistocene Fossil Locality in Botswana

ZACHARY W. PIERCE<sup>1</sup>, TIMOTHY L. CAMPBELL<sup>2</sup> and PATRICK J. LEWIS<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, Sam Houston State University, <sup>2</sup>Department of Anthropology, Texas A&M University

The Koanaka Hills, located in the Ngamiland District of Botswana, are one of a few fossil-bearing sites geographically intermediate to the productive Plio-Pleistocene fossil localities of eastern and southern Africa. Prior excavations of the internal cave deposits at this site produced a mid-Pleistocene date estimate of  $\geq 317,000 \pm 114$  ka ago using thermoluminescence, and yielded a new subspecies of baboon, *Papio hamadryas botswanae*. Due to their spatiotemporal placement, an understanding of paleoenvironmental change at the Koanaka Hills can provide important information on the evolution and biogeographic history of many African lineages. Renewed excavations at this site during the summers of 2007-2009 produced a rich collection of fossil mammalian microfauna. Microfauna are integral to rebuilding past environments as they are particularly sensitive to environmental change. During these excavations many rodent taxa were found including otomyines and *Mystromys*, none of which are found in the region today. Modern distributions and habitat use by these taxa suggest a wetter, cooler period at the Koanaka Hills during the mid-Pleistocene and a paleohabitat which included the presence of rank vegetation with a greater wooded component than present today. These conditions probably reflect the influence of the nearby Okavango

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Delta and documents a warming and drying of conditions from the mid-Pleistocene to those seen today in the Koanaka area.

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### Discrete dental traits differentiating *Australopithecus africanus* and *Paranthropus robustus* evaluated from the perspective of a Great Ape Dental Scoring System

VARSHA C. PILBROW

Anatomy and Neuroscience, University of Melbourne

*Australopithecus africanus* and *Paranthropus robustus* exemplify the use of discrete, or non-metric, dental traits in fossil hominin systematics. With relatively large sample sizes, dental traits differentiating these taxa are well documented and have been compared with the dental trait system in modern humans to evaluate patterns of variation. Comparisons with closely related Great Apes, however, are limited. The aim of this study is to use a newly devised Great Ape Dental Scoring System to evaluate the polarity of dental traits in *A. africanus* and *P. robustus* from the perspective of trait occurrence and frequency in species of *Pan*, *Gorilla* and *Pongo*.

Dental traits on the incisors, canines, premolars and molars were scored on a maximum of 27 *A. africanus*, 16 *P. robustus*, 288 *P. troglodytes*, 45 *P. paniscus*, 223 *G. gorilla*, 88 *G. beringei*, 76 *P. pygmaeus* and 25 *P. abelii*. Although hampered by negligible samples for some teeth, 86% of traits could be scored on the hominins. There are fewer (12) statistically significant chi-square differences between hominin species than between species of extant apes (36-38). However, trait frequencies differ greatly between hominin species, so that a hierarchical clustering procedure returned a 33% longer branch-length separating the hominins compared with species of extant apes.

This study supports the generic difference between *A. africanus* and *P. robustus*. The Great Ape Dental Scoring System when used together with the modern human dental trait system is likely to provide a better understanding of dental trait polarity in fossil hominin taxonomy and phylogeny.

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### Mobility in Neolithic Central Anatolia: A Comparison of Dental Morphometrics and aDNA

MARIN A. PILLOUD<sup>1</sup>, MEHMET SOMEL<sup>2</sup>, SCOTT D. HADDOW<sup>3</sup>, CHRISTOPHER J. KNÜSEL<sup>3</sup>, CLARK SPENCER LARSEN<sup>4</sup>, MIHRIBAN ÖZBAŞARAN<sup>5</sup>, OMUR DILEK ERDAL<sup>6</sup>, DOUGLAS BAIRD<sup>7</sup>, JESSICA PEARSON<sup>7</sup>, ANDERS GÖTHERSTRÖM<sup>8</sup>, JAN STORÅ<sup>8</sup>, MATTIAS JAKOBSSON<sup>9</sup>, GÜLŞAH MERVE KILINÇ<sup>2</sup>, FÜSUN ÖZER<sup>2</sup>, DILEK KOPTEKİN<sup>2</sup> and NIHAN DİLŞAD DAĞTAŞ<sup>2</sup>

<sup>1</sup>Anthropology, University of Nevada, Reno,

<sup>2</sup>Department of Biological Sciences, Middle East Technical University, <sup>3</sup>PACEA UMR 5199, Université de Bordeaux, France, <sup>4</sup>Anthropology, The Ohio State University, <sup>5</sup>Archaeology Department, Istanbul Üniversitesi, <sup>6</sup>Department of Anthropology, Hacettepe Üniversitesi, <sup>7</sup>Department of Archaeology, Classics, and Egyptology, University of Liverpool, <sup>8</sup>Department of Archaeology and Classical Studies, Stockholm University, <sup>9</sup>Department of Organismal Biology, Uppsala University

The Neolithic is characterized by the domestication of plants and animals and the adoption of sedentism. This period, often called the "Neolithic Revolution," represents a key transition in human cultural evolution with long-term impacts on social structure, economy, biology, and the demographic composition of populations in the Near East and Europe. The earliest evidence for this sociocultural transformation is in the Near East extending from the Levant into Anatolia where it developed for nearly four millennia (11,000 BCE to 7,000 BCE) before spreading into neighboring regions (Özdoğan, 2010). To better understand how these early Neolithic communities were created, interacted, and moved, this study explores skeletal and genetic data from Central Anatolia.

This study involves analyses of data on dental metrics and morphology, and nuclear DNA from skeletal remains unearthed at multiple sites (Boncuklu, Aşıklı Höyük, Musular, and Çatalhöyük) that span the early to later Neolithic in Anatolia (8500 – 5950 BCE). Initial results of dental metric and genetic data show that early sites (i.e., Boncuklu and Aşıklı) have low levels of genetic diversity, and over time sites become less endogenous (i.e., Çatalhöyük). This finding suggests regional development of communities that over time began to interact with each other, eventually leading to larger village settlements. Data on dental morphology and metrics (Aşıklı Höyük, Musular, and Çatalhöyük) suggest a patrilocal postmarital residence practice was employed, which has implications for the movement of people across space and the development of structured societies over time.

### Patellar response to knee flexion in the Miocene primates *Epipliopthecus vindobonensis* and *Pierolapithecus catalaunicus*

MARTA PINA<sup>1</sup>, DANIEL DEMIGUEL<sup>2</sup>, FRANCESC PUIGVERT<sup>3</sup>, JORDI MARCÉ-NOGUÉ<sup>4</sup> and SALVADOR MOYÀ-SOLÀ<sup>1,5,6</sup>

<sup>1</sup>Paleoprimatology and Human Paleontology, Institut Català de Paleontologia Miquel Crusafont, <sup>2</sup>Neogene and Quaternary Faunas, Institut Català de Paleontologia Miquel Crusafont, <sup>3</sup>Resistència de Materials i Estructures a l'Enginyeria, Universitat Politècnica de Catalunya, BarcelonaTech, <sup>4</sup>Centrum für Naturkunde, University of Hamburg, <sup>5</sup>ICREA, Institut Català de Paleontologia Miquel Crusafont, <sup>6</sup>BAVE, Universitat Autònoma de Barcelona

The knee plays a central role for primate locomotion since it participates in body weight bearing, propulsion and support. Living non-human hominoids show a versatile knee that allows them to rely on a varied and non-stereotyped set of joint movements during orthograde behaviors. In this regard, studying the Miocene primates becomes essential to understand the origin and evolution of these positional behaviors within the Hominoidea. Here, the patellar response during several phases of knee flexion is inspected through Finite Element Analysis (FEA) in the stem putative catarrhine *Epipliopthecus vindobonensis* (early Middle Miocene) and the stem great ape *Pierolapithecus catalaunicus* (the oldest unambiguous orthograde primate; late Middle Miocene). In order to simulate knee flexion, the quadriceps muscle and the patellar ligament attachment areas were selected as constrained regions. Besides, the patellar articular surface was divided in three strips to simulate the proximal displacement of the patellofemoral contact during knee flexion. A pressure in every strip was applied and results for von Mises stress were obtained. FEA results show that stress distribution in *Epipliopthecus* is similar to that of extant *Colobus* and *Hylobates*; whereas in the case of *Pierolapithecus*, its biomechanical response resembles that of living *Pongo* and *Pan*. Biomechanical similarities with colobines and gibbons suggest therefore a diverse positional behavior repertoire for *Epipliopthecus*, which probably relied habitually on several locomotor modes. Otherwise, results obtained for *Pierolapithecus* advocate for a more great ape-like versatile joint response, thus supporting the hypothesis that it probably engaged in orthograde-like behaviors such as vertical climbing.

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### Which Tooth Best Predicts Diet using Dental Complexity in Fossil Primates?

SILVIA PINEDA-MUNOZ<sup>1</sup> and IGNACIO A. LAZAGABASTER<sup>2,3</sup>

<sup>1</sup>Paleobiology, NMNH Smithsonian Institution, <sup>2</sup>Institute of Human Origins, Arizona State University, <sup>3</sup>School of Human Evolution and Social Change, Arizona State University

The physical properties of foods drive the evolution of functionally optimal dentitions. Thus, dental morphology provides an excellent tool for inferring diet in extinct species. In order to account for the complexity of whole dentitions, analysis of dental morphology requires complete molar tooth rows. Well-preserved and complete primate tooth rows are rare in the fossil record, which makes morpho-functional inferences difficult. Here we investigated whether isolated teeth can be used as proxies for dietary inferences in fossil primates and which tooth are the best predictor. We three-dimensionally scanned the dentitions of 12 extant primate species and classified their diets as herbivory, frugivory, insectivory, gumivory, or generalized. We then applied multi-proxy dental morphology analysis (MPDMA), a novel methodology that has proven to be a good tool for dietary inferences. Orientation patch count (OPCR), slope diversity, and relief index were calculated from dental 3D scans of each species and multivariate statistical analyses were used to test for discriminatory power. We performed the analyses for each individual tooth and for whole tooth rows. MPDMA on whole tooth rows demonstrates significant morphological differences (MANOVA  $p < 0.05$ ) and correctly discriminates diet for up to 83% of the species. Among individual teeth, lower M1 provide the best discriminatory power (83%) followed by upper M1 (75%). This study justifies the use of isolated molars for dietary reconstruction and indicates which molars are most informative. Further analysis using this technique will provide a strong background for the study of diet and dental morphology in fossil primates.

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### Observer Variability in Identification of Histological Structures in Silver-Stained Bone Thin Sections

DEBORRAH C. PINTO<sup>1</sup>, CHRISTIAN M. CROWDER<sup>1</sup> and GARRETT T. PHILLIPS<sup>2</sup>

<sup>1</sup>Forensic Anthropology Division, Harris County Institute of Forensic Sciences, <sup>2</sup>Pathology Services, Harris County Institute of Forensic Sciences

The use of bone histology in age estimation has been well established in forensic anthropology. Observer variability (error) in quantifying the microanatomical structures used by the age estimation methods is a persisting issue. This

variability has been attributed to many factors of which subjective definitions for these structures and their visualization in undecalcified thick sections (eg: blurry cement lines) have been identified as primary contributors. Crowder et al. (2012) suggested honing the descriptions of these structures to decrease this variability. In 2015, Pinto and Pace suggested using a silver-stain method on decalcified bone which allows better visualization of these microanatomical structures. The goal of this pilot study is to combine these two suggestions to assess if variability can be reduced. Thirty five microscope photographs taken from six ribs acquired during autopsies on different decedents were examined. Three observers (2 anthropologists and 1 pathologist) with experience in histology recorded the number of intact and fragmentary osteons in each image using specific definitions. Only one observer (pathologist) did not have previous training using the histological age estimation methods. Technical Error of Measurement (TEM) for intact and fragmentary osteon counts was 0.83 and 2.10, respectively. The correlation coefficient (R) for both variables was  $>0.98$ . The TEM and R results indicate high reliability. Average bias between observers was low, ranging from 0.2 to 0.8 for intact osteons and -1.54 to 0.83 for fragmentary osteons. The results show low observer variability when using the suggested modifications; however, additional testing on a larger sample is needed.

### Human incremental hard tissue formation as evidence of a biorhythm: preliminary results

ROSIE PITFIELD and PATRICK MAHONEY  
Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent

Recent studies indicate a potential link between tooth enamel Retzius periodicity (RP) and the time taken to form one bone lamellae for some mammalian species. It has been hypothesized that this correlation is influenced by a biorhythm. So far, this has been explored in single bones, but bone formation varies intra-skeletally. Here we test the hypothesis in a sample of ten adult human skeletons ( $n=5$  male;  $n=5$  female). Using histological methods, we calculated RP of permanent molars for each skeleton, and combined this with measures of bone formation, calculated from osteocyte lacunar density, for eight different bones from each skeleton. Results from this preliminary study show RP is negatively but not significantly correlated with bone formation in lower limb bones. However, there is no correlation between RP and osteocyte lacunar density in the rib, which has a relatively fast rate of bone turn over, or the occipital bone, which has a slower rate of bone turn over. Our observations support the idea that aspects of human hard tissue growth might be coordinated by an

underlying biorhythm, but the relationship with RP and intra-skeletal variation in bone growth in humans is still unclear. Ongoing research will further explore RP and bone growth rates.

### Evaluating the utility of extant reference samples for modelling hominin taxonomic variation

J. MICHAEL PLAVCAN  
Anthropology, University of Arkansas

Alpha taxonomy of paleontological samples frequently relies on comparisons to variation in extant species. While it is well-known that geographic (and by inference, temporal) variation can significantly contribute to variation in fossil assemblages, most paleoanthropological studies use extant apes as models. Conspecificity is usually supported if variation among specimens does not exceed that of a living reference sample. Occasionally minor metric difference are interpreted as consistent with temporal or geographic variation within a single species. Rarely considered is the degree to which modern closely related species actually differ from another in characters measurable in the fossil record. This analysis compares univariate, bivariate and multivariate distributions of extant catarrhine craniometric data to assess whether closely related species and subspecies could be recognized if encountered in the fossil record. Published craniometric data for a series of hominins were gathered. Standard linear craniometric data for 1976 catarrhine specimens, comprising guenons, *Macaca*, African colobines, hylobatids and apes from 64 extant taxa, were included. All data were ln-transformed. Body size, diet, habitat, phylogenetic diversity, and geographic range were not systematically correlated with morphological diversity. Species and subspecies could be separated using complete data sets, but overlap was still extensive. Though generically diverse, the hominin data of this study show relatively little total variation by comparison to most taxonomic groups for most measures. The results demonstrate that common metric data should grossly underestimate taxonomic diversity, and suggest that significant differences for relatively few morphological characters strongly imply taxonomic diversity.

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### Historic and Skeletal Mortality of the Mississippi State Asylum

AMBER M. PLEMONS<sup>1</sup>, MICHELLE L. DAVENPORT<sup>2</sup> and NICHOLAS P. HERRMANN<sup>3</sup>

<sup>1</sup>Anthropology, Michigan State University, <sup>2</sup>Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>3</sup>Anthropology, Texas State University

Historical and skeletal data for a specific population provides invaluable information for

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bioarchaeological assemblages. This study compares Gompertz-Makeham mortality models for the Mississippi State Asylum (MSA) Cemetery (1855-1935) skeletal assemblage (n=67) and the MSA death records for 3,445 individuals. Additionally, the relationship between oral pathologies, including LEHs, caries, and antemortem tooth loss as well as Diseased-Missing Index, within the skeletal assemblage and prevalent diseases recorded in the death records are assessed.

Skeletal ages were calculated using transitional analysis within ADBOU software. Maximum likelihood skeletal ages and ages provided in the MSA death records were imported into *mle*, a maximum likelihood analysis program. Gompertz-Makeham models were compared using a Chi-squared distribution (df=2). The skeletal and historical mortality models produced no significant differences between the two datasets. Percentage of male and female representation were equivalent in both datasets. No significant differences in mortality were determined when comparing sex within and between skeletal and historical data; however, females demonstrated lower survivorship than males within both datasets. Death records indicated a significant presence of pellagra (23.64% of death entries), particularly in females (31.33%). Females also exhibited a greater number of stress episodes based on LEH frequencies. Oral pathology affected over half of the assemblage indicating poor health across the assemblage.

A discussion will be provided on oral pathologies and disease-specific mortality in relation to frailty within the MSA assemblage. Combining historical and skeletal data allowed for the exploration of life histories and implications of disease on frailty and mortality within the MSA patient population.

### **Bipedalism evolved from Knuckle-walking: Evidence from 3D Geometric Analyses of Thoracic and Lumbar Vertebral shape of *Homo sapiens*, *Pan troglodytes*, and *Pongo pygmaeus***

KIMBERLY A. PLOMP<sup>1</sup>, UNA STRAND VIDARSDOTTIR<sup>2</sup>, DARLENE WESTON<sup>3</sup>, KEITH DOBNEY<sup>4</sup> and MARK COLLARD<sup>1,5</sup>

<sup>1</sup>Archaeology, Simon Fraser University, <sup>2</sup>Biomedical Center, University of Iceland, <sup>3</sup>Department of Anthropology, University of British Columbia, <sup>4</sup>Department of Archaeology, Classics, and Egyptology, University of Liverpool, <sup>5</sup>Department of Archaeology, University of Aberdeen

The locomotor behaviour of the last common ancestor (LCA) of hominins and panins is a controversial topic. The main hypotheses posit that the LCA moved either like African apes or like orangutans. In this study, we attempt to test between these hypotheses by comparing the shape of the lower two thoracic and upper two

lumbar vertebrae of *H. sapiens*, *P. troglodytes*, and *P. pygmaeus*. We used 3D Cartesian coordinates to capture the shape of the vertebrae and then subjected the data to geometric morphometric analyses. Asymmetry was removed, and then allometry was minimized by regressing the landmark coordinates on log centroid size. Subsequently, the regression residuals were subjected to principal component analysis, and MANOVAs were performed on the PCs to assess the statistical significance of the differences among taxa. Additionally, between-group Euclidean distances were calculated to investigate inter-taxa shape variation. The analyses revealed a difference between the posterior and anterior parts of the vertebrae. They suggested that *H. sapiens* is more similar to *P. pygmaeus* in the posterior part of the vertebrae but more similar to *P. troglodytes* in the anterior part of the vertebrae. Given the species' phylogenetic relationships and locomotor behaviours, it is likely that the similarities between *H. sapiens* and *P. pygmaeus* are convergent, while those between *H. sapiens* and *P. troglodytes* are synapomorphic. This is consistent with the hypothesis that the LCA used knuckle-walking. Thus, the present study adds to the growing body of evidence indicating that knuckle-walking preceded bipedalism.

### **An evaluation of US educator product priorities and challenges for teaching human evolution**

BRIANA POBINER<sup>1</sup> and DAVID PATTERSON<sup>2,3</sup>

<sup>1</sup>Human Origins Program, Smithsonian Institution, <sup>2</sup>Department of Biology, University of North Georgia, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, George Washington University

Many physical anthropology research projects, particularly those that apply for funding from the National Science Foundation, create products for K-16 and informal learning educator audiences as part of their broader social impacts requirements. Educator input on these products, however, is often not sought. Here, we present quantitative and qualitative data from surveys of educators during workshops convened in conjunction with a Smithsonian traveling exhibit on human origins at public libraries across the US aimed at assessing educator product priorities. This study aims to evaluate factors that hinder effective teaching of human evolution in formal and informal education settings. To this end, we consider responses to 12 choices of possible products or efforts directed at mitigating these factors ranging from objects for classrooms, to "ready to go" lesson plans, to an online network of scientists to ask content questions, to concrete ideas to overcome the barriers to teaching human evolution, to statements by educational and religious organizations regarding their acceptance of evolution. Our data indicate that the need for updated, accessible scientific information and professional

development opportunities are important limiting factors in teaching human evolution. In addition, the survey respondents indicated that physical objects (e.g., skull replicas) for use in their educational settings, as well as videos, interactives, and other online materials, are most important for helping them effectively communicate topics related to human evolution. These data and analyses can help inform physical anthropologists that seek to create useful products and experiences for educators.

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### **Lateralization in the Slow Loris (*Nycticebus* spp.) 'Venom Pose'**

STEPHANIE A. POINDEXTER and K. A. I. NEKARIS

Anthropology and Geography, Oxford Brookes University

Lateralization in humans show a bias for right-handedness and to uncover the roots of this asymmetry, studies focus on laterality in non-human primates. Numerous studies on New World primates, Old World primates, and apes show varying preferences at the individual and population level. Here we contribute to the limited pool of research regarding strepsirrhines and laterality. In a non-experimental context, we analyzed 42 photos of three slow loris species' (*Nycticebus javanicus*, *N. coucang*, and *N. hilleri*) 'venom pose' taken between 2006 and 2014 including wild and captive individuals. The venom pose is unique to the slow loris as they grasp their hands above their head in threatening situations. Here we noted when 42 individuals used either their right hand to clasp their left wrist or their left hand to clasp their right wrist; in these scenarios we defined the clasping hand as the more active and dominant hand. We observed a right over left grip in 64% of individuals and a left over right grip in 36%. Following a Chi-squared test we found a significant difference between the two grips favoring a more dominant right hand grip ( $\chi^2=4.9$ ,  $df=1$ ,  $p=0.027$ ). Further research including a combination of experimental unimanual and bimanual tasks may provide different results. Overall, these findings suggest that the asymmetry seen in humans for right handedness may be rooted in early more primitive primates.

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### Genetics of Psychiatric Disorders and Behavioral Traits Correlate with Geo-climate Variables, Pathogen Diversity, and Language (phonological Complexity) in European Populations

RENATO POLIMANTI<sup>1</sup>, MANFRED KAYSER<sup>2</sup> and JOEL GELERNTER<sup>1,3</sup>

<sup>1</sup>Department of Psychiatry, Yale University School of Medicine and VA CT Healthcare Center, West Haven, CT, United States, <sup>2</sup>Department of Genetic Identification, Erasmus University Medical Center, Rotterdam, Netherlands, <sup>3</sup>Departments of Genetics and Neuroscience, Yale University School of Medicine, New Haven, CT, United States

Limited information is available regarding the evolutionary aspects of the genetic predisposition to psychiatric disorders and behavioral traits. Here, we conducted a genome-wide investigation to investigate whether the genetics of these phenotypes correlate with geographical environmental factors (geo-climate variables and pathogen diversity) and language complexity. We performed a high-resolution polygenic risk score (PRS) analysis in 2,455 individuals from 23 European populations considering the summary statistics of genome-wide association studies from the Psychiatric Genomics Consortium, the Genetics of Personality Consortium, and the Social Science Genetic Association Consortium. The analysis was adjusted for the genetic diversity of European populations (first 10 ancestry principal components) to ensure that the differences detected would reflect differences in environmental exposures. The top finding was related to the positive association between winter minimum temperature and schizophrenia PRS ( $R^2=0.40\%$ ,  $p=1.28*10^{-4}$ ). Winter minimum temperature was also associated with PRS related to major depression disorder ( $R^2=0.30\%$ ,  $p=8.46*10^{-4}$ ) and extraversion ( $R^2=0.26\%$ ,  $p=1.74*10^{-3}$ ). There is a well-known association between winter birth and schizophrenia risk. Beyond geo-climatological parameters, we also observed three results related to pathogen diversity and language phonological complexity: openness-to experience PRS was positively associated with protozoan diversity ( $R^2=0.18\%$ ,  $p=3.82*10^{-4}$ ) and language consonants were negatively associated with conscientiousness PRS ( $R^2=0.28\%$ ,  $p=2.98*10^{-3}$ ) and positive associated with extraversion PRS ( $R^2=0.26\%$ ,  $p=4.13*10^{-3}$ ). Based on these findings, we hypothesize that certain environmental factors contributed to shape the genetic architecture of psychiatric disorders and behavioral traits and that the genetics of these traits in some measure affected the linguistic characteristics of European populations.

This study was supported by a NARSAD Young Investigator Award from the Brain & Behavior Research Foundation.

### Niche Partitioning, Diet, and Oral Processing Behaviors in Three Sympatric Guenons in the Tai National Park, Côte d'Ivoire

TAYLOR A. POLVADORE<sup>1</sup>, ERIN E. KANE<sup>2</sup>, M. ALEXANDRA WILKINS<sup>2</sup>, FREDERIC M. GNEPA<sup>3</sup>, DAVID J. DAEGLING<sup>1</sup> and W. SCOTT MCGRAW<sup>2,3</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Anthropology, The Ohio State University, <sup>3</sup>Tai Monkey Project, Tai, Côte d'Ivoire

Although sympatric guenons in Côte d'Ivoire's Tai National Park experience significant dietary overlap, they coexist through ecological partitioning. Diana monkeys (*Cercopithecus diana*) exploit the upper canopy and incorporate significant amounts of fruit; Campbell's monkeys (*C. campbelli*) exploit the understory and ground, consuming mostly fruit and invertebrates; and lesser spot nosed guenons (*C. petaurista*) use the middle canopy, consuming more foliage than their congeners. Here, we present novel data on differences in oral processing and ingestive behavior in these three taxa.

Data on the number of mastications per minute were collected on habituated individuals in the Tai Forest between June and August 2016 (*C. diana* N=300; *C. campbelli* N=194; *C. petaurista* N=38). There is no difference in the mastication frequency utilized by the Diana monkeys and lesser spot nosed guenons ( $p$ -value= 0.585). Campbell's monkeys masticate at a significantly lower frequency than that of their congeners ( $p$ -value= 0).

Our results indicate that these taxa process their food in different ways despite similarity in food types. Though Diana monkeys and Campbell's monkeys ingest large amounts of fruit, Campbell's monkeys process their food with fewer chews than the Diana monkey. Lesser spot nosed guenons incorporate more foliage, but consume these foods with similar processing time to that of the Diana monkey. Due to the low sample size of the lesser spot nosed guenons, our results are preliminary. However, these results indicate differences in the stresses and mechanical demands of oral processing experienced by closely-related, sympatric taxa with dietary overlap, but divergent ecological strategies.

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### Evidence of an ancient origin for contemporary chronic disease risk in South Asia

EMMA POMEROY<sup>1,2</sup>, VEENA MUSHRIF-TRIPATHY<sup>3</sup>, JAY T. STOCK<sup>4</sup> and JONATHAN C.K. WELLS<sup>5</sup>

<sup>1</sup>McDonald Institute for Archaeological Research, University of Cambridge, UK, <sup>2</sup>School of Natural Sciences and Psychology, Liverpool John Moores University, <sup>3</sup>Department of Archaeology, Deccan College Postgraduate and Research Institute, Pune, India, <sup>4</sup>Division of Archaeology, University of Cambridge, UK, <sup>5</sup>Childhood Nutrition Research

Centre, Institute of Child Health, University College London, UK

Chronic diseases (type 2 diabetes, cardiovascular disease) are a leading cause of global morbidity and mortality. While diet and activity levels have a central role in increasing chronic disease rates, the heightened susceptibility of certain populations, e.g. South Asians, suggests a longer-term component to disease risk in some groups. Contemporary South Asians have low lean (organ and muscle) mass relative to height and total body mass, which appears to be heritable and is implicated in their elevated chronic disease susceptibility. When and why this 'thin-fat phenotype' arose is unknown but relevant to fully understanding the determinants of disease risk. Proposed explanations for South Asian low lean mass include the impacts of: climatic adaptation; the agricultural transition; vegetarianism; or colonial policies exacerbating 19th century famines. We investigated the origins of low lean mass by comparing Holocene Indian archaeological skeletons to worldwide data from hunter-gatherers and agriculturalists. We used z scores for measurements correlating with stature (bone lengths) and body mass (breadths), on the basis that low mass relative to stature will reflect proportionally low lean mass. Bone length and breadth z scores indicate South Asian hunter-gatherers were tall with very low relative mass. Following the agricultural transition, bone lengths decreased while breadths remained similar, but still low relative to length compared with worldwide populations. Twentieth century skeletons from India have similarly low breadths relative to lengths as archaeological agriculturalists. Our results suggest an ancient origin for low lean mass and heightened chronic disease risk among contemporary South Asians.

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### Obstetric and Non-obstetric Determinants of Pelvic Sexual Dimorphism in Hylobatids

MARCIA S. PONCE DE LEÓN, MARC SCHERRER and CHRISTOPH P. E. ZOLLIKOFER

Anthropological Institute and Museum, University of Zurich

The evolution of secondary sexual dimorphism represents a classic case of intraspecific evolutionary conflict: Female and male morphologies evolve toward distinct, sex-specific fitness peaks, but the development of both morphologies is governed by the same set of autosomal genes. In the case of modern humans, it is traditionally assumed that obstetric versus locomotor constraints represent the major selective forces driving sex-specific pelvic morphologies apart. However, this hypothesis has been falsified by recent studies, such that alternative explanations for pelvic sexual dimorphism need to be sought.

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Here we approach this issue with a study of pelvic morphology in two hylobatid species, *Hylobates lar* and *Symphalangus syndactylus*. These species differ in body size, encephalization, and fetopelvic relationships, but both exhibit only little sexual dimorphism in body size. Computer-assisted simulations of the birthing process show substantial obstetric constraints in *H. lar*, but not in *S. syndactylus*. Geometric-morphometric analysis of pelvic ontogeny shows that, with the onset of puberty, *H. lar* develops sexually dimorphic pelvic shapes, while no such effects could be observed in *S. syndactylus*. These data suggest that pelvic sexual dimorphism in hylobatids has evolved as a response to obstetric constraints, and that it develops under the influence of sex-specific hormone levels. The actual morphological pattern of pelvic dimorphism in *H. lar* is similar to that of humans: obstetrically relevant dimensions are relatively larger in females than in males, while overall pelvic size is similar in both sexes.

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### How Much Food do Animals Need to Walk, Run, and Climb? This Much

HERMAN PONTZER

Department of Anthropology, Hunter College, New York Consortium for Evolutionary Primatology

Humans and other animals with legs need food to walk, run, and climb. But how much? Smaller animals use very little food to climb, but use a lot of food to walk. Big animals use a lot of food to climb, but not to walk and run. Here, I show a new way of figuring out how much food animals need to walk, run, and climb. Animal legs have red parts inside that move them; these red parts need food to turn on and off and to do work. I use numbers to show that the on/off and work that the red parts do tells us exactly how much food animals need to walk, run, and climb - even very small animals and very big animals, no matter how many legs they have. I use this idea to figure out how much food humans, living human-like animals, and long-dead human-like animals use to walk, run, and climb.

This work was supported by Hunter College.

### The New Genus *Paragalago* Suggests Convergent Dwarfism in the family Galagidae

LUCA POZZI<sup>1</sup> and JUDITH C. MASTERS<sup>2</sup>

<sup>1</sup>Department of Anthropology, UNIVERSITY OF TEXAS AT SAN ANTONIO, <sup>2</sup>Department of Zoology & Entomology, University of Fort Hare

The family Galagidae (the galagos or bushbabies of Africa) currently comprises five genera: *Euoticus*, *Galago*, *Galagoides*, *Otolemur* and *Sciuocheirus*. Because of the relatively recent discovery of cryptic diversity within the genera,

none of them is generally regarded as monotypic, but some (*Euoticus*, *Otolemur*) certainly qualify as oligotypic. Here we discuss evidence that *Galagoides* does not constitute a clade in molecular phylogenetic reconstructions and is unlikely to have shared an exclusive common ancestor. Based on molecular phylogenetics, biogeography, craniodental morphometrics and vocal communication, we argue that a new genus is necessary to accurately reflect galagid evolutionary history. More specifically, the dwarf galagos confined to the forests of East and southern Africa (*Gs cocos*, *Gs granti*, *Gs orinus*, *Gs rondoensis* and *Gs zanzibaricus*) require to be placed in their own genus, *Paragalago*. The polyphyletic status of dwarf galagos also implies convergent body size reduction within the Galagidae. Phylogenetic reconstructions of the ancestral body size within the Lorisiformes (Galagidae and Lorisidae) support at least two independent events of body size reduction (~40%). Interestingly, Malagasy lemurs have experienced similar changes in body mass at around the same period of time (Mid-Late Miocene), probably as an adaptation to environmental unpredictability. Biogeographical analyses suggest that similar climatic conditions in Sub-Saharan Africa might have affected body size also within the galagids.

### Fosterage on Adult Strength and Body Fat in Himba Women

SEAN PRALL and BROOKE SCELZA

Anthropology, University of California, Los Angeles

Child fosterage has frequently been shown to be associated with negative health effects, including increased risk of malnutrition. Few studies have investigated whether these effects carry through to adulthood. Here we investigate the effects of fosterage on adult health among the Himba, a semi-nomadic pastoralist population with high rates of fosterage. Fosterage histories, anthropometrics and two strength measures were collected from 77 Himba women (average age = 36, 19.5% fostered). Separate regression models were used to predict the effects of childhood fosterage status on adult height, body fat and strength measures, controlling for age, parity and current marital status. Fosterage status was a positive predictor of adult body fat ( $\beta = 0.22$ ,  $P < 0.05$ ) and grip strength ( $\beta = 0.24$ ,  $P < 0.05$ ) but had no significant effect on adult height or chest strength. Contrary to its effects on child health, fosterage among the Himba has neutral to positive effects on adult health.

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### Functional and Evolutionary Implications of the *Homo naledi* Rearfoot

THOMAS C. PRANG

Center for the Study of Human Origins, Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology (NYCEP)

The functional morphology of the foot provides insight into the evolution of bipedalism and the locomotion of Plio-Pleistocene hominins, but foot fossils are relatively rare. Recently discovered fossils attributed to the new species *Homo naledi* include the rare occurrence of an associated talus and calcaneus—two bones that have been argued to reflect variation in hominoid rearfoot posture. These new fossils provide novel insight into existing hypotheses of hominin foot evolution. In univariate and multivariate analyses of extant hominoid rearfoot morphology, I show that *H. naledi* retains the inferred plesiomorphic, African ape-like condition for several functionally relevant rearfoot traits, which suggests that it lacked a modern human-like longitudinal arch and calcaneal tuber, much like *Australopithecus sediba*. In contrast, *Australopithecus afarensis* is most similar to modern humans and Neanderthals in rearfoot angular relationships and calcaneal tuber robusticity. Homology of the derived rearfoot traits shared by *A. afarensis* and modern humans requires a minimum of two evolutionary reversals when evaluated in a phylogenetic context. The most parsimonious hypothesis is that *A. afarensis* evolved its derived rearfoot morphologies independently of modern humans, which is congruent with evidence from other areas of the postcranium and recently published body mass estimates. The potential for the independent evolution of postcranial traits associated with advanced terrestriality provides a new perspective on debates about the locomotor behavior of *A. afarensis* and other early hominins.

### Baseline characterization and biogeochemical variation for the identification of paleomobility in the Aegean

ELEANNA PREVEDOROU<sup>1,2</sup>, JANE E. BUIKSTRA<sup>2</sup>, GWYNETH W. GORDON<sup>3</sup> and KELLY J. KNUDSON<sup>2</sup>

<sup>1</sup>Wiener Laboratory, American School of Classical Studies at Athens, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>School of Earth and Space Exploration, Arizona State University

The application of biogeochemistry for the identification of paleomobility, particularly radiogenic strontium isotope analysis (<sup>87</sup>Sr/<sup>86</sup>Sr), is a growing field in bioarchaeology. Nevertheless, the characterization of "local" zones and interregional biogeochemical variation, and the availability of comparative data still constitute challenging aspects. The use of fauna is established as a proxy for the locally bioavailable <sup>87</sup>Sr/<sup>86</sup>Sr ratios, while modern samples are often used either in comparison to, or in substitute for archaeological fauna. Sampling modern specimens, however,

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might not be possible in areas where domestic animals feed on processed food.

In this study, we systematically sampled tissues from legal modern game from different locations throughout Greece. We collected hare (*Lepus europaeus*) and wild rabbit (*Oryctolagus cuniculus*) specimens that live and feed in the wild and have a narrow foraging range. The modern faunal samples showed a range between  $^{87}\text{Sr}/^{86}\text{Sr} = 0.70757 - 0.71068$  and mean  $^{87}\text{Sr}/^{86}\text{Sr} = 0.70875 \pm 0.00054$  ( $1\sigma$ ,  $N=119$ ). The faunal results generally followed the expected variation based on the local geology. Significant interregional differences in  $^{87}\text{Sr}/^{86}\text{Sr}$  values were detected. However, sea salt and sea spray seem to have a significant effect in coastal, lowland regions. This observation, in addition to the common underlying limestone formations, suggest that mobility between certain regions might not be detected using  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios and that the use of very narrow "local" ranges should be avoided. Overall, the results of this study prove the utility of modern game as a tool for characterizing locally bioavailable  $^{87}\text{Sr}/^{86}\text{Sr}$  values and suggest future directions for biogeochemical research.

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### Stable Carbon and Oxygen Isotope Analysis of Archaeological Dental Calculus: Potential for Future Study

SAMANTHA DR. PRICE<sup>1</sup>, HENRY P. SCHWARCZ<sup>2</sup> and ANNE KEENLEYSIDE<sup>3</sup>

<sup>1</sup>Department of Anthropology, McMaster University, <sup>2</sup>School of Geography & Earth Sciences, McMaster University, <sup>3</sup>Department of Anthropology, Trent University

Twenty-seven individuals from the Greek Colonial site of Apollonia Pontica, Bulgaria (5<sup>th</sup> to 3<sup>rd</sup> century BC) were sampled for paired dental calculus and bone samples. A protocol was developed to extract the inorganic dental calculus component for stable carbon and oxygen isotope composition for comparison to bone carbonate. The  $\delta^{13}\text{C}$  values of dental calculus are different from that in bone, however, there is little variation. This is indicative of an offset between the two materials, but is this offset due to diagenesis? Stable isotope results show that the  $\delta^{18}\text{O}$  values (-4.70 and -4.57) have almost identical means, with considerable overlap, despite the higher range of values from the calculus samples. Multiple dental calculus samples were analyzed for two individuals, with little variation discovered in the oxygen isotope values (s.d. = 0.7 for both). FTIR analysis of dental calculus samples was completed following protocol used for modern dental calculus samples in Hayashizaki et al. (2008). The mean crystallinity indices of the modern sample compared to those from the current study were identical (3.2), indicating that no diagenesis has

taken place. Further comparisons between the values from bone and calculus, as well as the consistency between multiple calculus samples from the same individual indicates that the  $\delta^{18}\text{O}$  values could also be used to test for diagenesis of the mineral component of dental calculus. These results provide support for the potential use of stable carbon and oxygen isotopes from bone carbonate in paleodietary ( $\delta^{13}\text{C}$ ) and paleoclimate ( $\delta^{18}\text{O}$ ) studies.

*This research was funded by the Social Sciences and Humanities Research Council (SSHRC) Canada Graduate Scholarship and the Trent University Archaeological Research Centre (TUARC)*

### Stable Isotope Analysis of Human Diet at the Santa Bárbara Mining Encampment

TERREN K. PROCTOR<sup>1</sup>, DOUGLAS K. SMIT<sup>2</sup> and TIFFINY A. TUNG<sup>1</sup>

<sup>1</sup>Anthropology, Vanderbilt University, <sup>2</sup>Anthropology, University of Illinois at Chicago

Santa Bárbara was the primary settlement associated with the mines at Huancavelica, which were the largest suppliers of mercury in the Spanish colonies from 1564 – 1810 CE. At the time of operation, these quicksilver mines had a labor force of primarily male indigenous workers. Eight human burials recovered from the site provide a unique opportunity for observing the lifeways of these colonial-era mercury miners. In particular, stable carbon and nitrogen isotope analysis of bone collagen and stable carbon isotope analysis of dental enamel is employed to reconstruct the diet of the individuals living in the encampment. Multiple bone and dental samples were taken from each of the eight individuals. Samples from seven of those individuals yielded stable isotope results. Among those samples, the  $\delta^{13}\text{C}$  ranges from -16.6‰ to -11.0‰, and the mean  $\delta^{13}\text{C}$  is -14.2‰. The range of  $\delta^{15}\text{N}$  values is 8.9‰ to 14.3‰, and the mean  $\delta^{15}\text{N}$  is 9.8‰. One sample taken from a late-term human fetus shows an elevated stable nitrogen isotope ratio of 14.3‰ ( $p < 0.05$ ), which is presumably due to fractionation across the placental tissue. Excepting this outlier, the consistency in values across all other individuals indicates that the inhabitants experienced similar diets that included terrestrial protein, likely in the form of camelids or guinea pig, as well as maize.

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### Assessing Age-Related Mortality at Petra, Jordan Using Cementochronology and Hazard Modeling

AKACIA S. PROPST and MEGAN PERRY

Department of Anthropology, East Carolina University

Many infectious diseases that resulted in high mortality in the past often do not result in identifiable skeletal lesions, rendering them essentially invisible in the skeletal record. Age-at-death mortality profiles provide an important supplementary record of disease-related mortality risks that archaeological populations faced. For instance, cemeteries primarily containing individuals perishing from catastrophic events, such as natural disasters or disease epidemics, will have a different age-related mortality profile than one created through normal attrition. Previous research on a 1<sup>st</sup> century BC to 1<sup>st</sup> century AD skeletal assemblage from the ancient city of Petra discovered significantly fewer skeletal lesions related to infectious disease processes than contemporary sites from the region. Here, we use hazard modeling to calculate risk of death by age for adults in the Petra sample to identify forces resulting in its creation. Age-at-death estimates used for the hazard model come from 71 individuals that were generated using cementochronology, which not only provides more accurate age estimates, but increases our sample size due to the fragmented and commingled nature of the Petra assemblage. Our results indicate that the mortality profile from Petra resembles that of an attritional sample, indicating that the lack of disease pathologies did not result from people perishing from catastrophic events not reflected in the skeleton.

*This research is partially funded by NEH Collaborative Grant #RZ-51555-13 and NGS Research Grant #19162630.*

### Isotopic Evidence for Diet in Iron Age and Roman Apulia – Conformity in the Face of Major Social Change?

TRACY L. PROWSE and LISA SEMCHUK  
Anthropology, McMaster University

Archaeological and historical evidence indicates that the end of the Iron Age in southern Italy was characterized by political and social upheaval associated with a series of battles between the expanding Roman Republic, indigenous Italian groups, and other rival nations. The outcome for the region known as Apulia was the subjugation of local populations, a decline in settlement size and density, and the confiscation of land by the Romans. This region saw a resurgence of settlements during the Roman Imperial period (1<sup>st</sup> – 4<sup>th</sup> c. CE).

This presentation explores whether this upheaval and demographic transition led to a shift in diet between these two periods through the isotopic analysis of bone collagen from three Iron Age (7<sup>th</sup> - 4<sup>th</sup> c. BCE) sites (n= 25) outside the modern city of Gravina in Puglia, and the nearby Roman Imperial (1<sup>st</sup> - 3<sup>rd</sup> c. CE) site of Vagnari (n=80). Results indicate that for those individuals who were fully weaned (>3 years old), there is virtually

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no difference between the Iron Age (average  $\delta^{13}\text{C}$  -19.2‰,  $\delta^{15}\text{N}$  9.4‰) and Roman samples (average  $\delta^{13}\text{C}$  -19.2‰,  $\delta^{15}\text{N}$  9.2‰), at least with respect to dietary protein. Similarly, there are only slight differences between subadults from the Iron Age and Roman periods who were still breastfeeding and/or going through the weaning process (<3 years old) (average difference:  $\delta^{13}\text{C}$  -0.4‰ and  $\delta^{15}\text{N}$  0.3‰). These results suggest that even in the light of major social, economic, and political change, the diet of inhabitants in this region remained relatively consistent.

### Analyzing the Morpho-functional Consequences of Seed Predation in the Pitheciid lower Jaw using Finite Element Analysis and Geometric Morphometrics

THOMAS A. PÜSCHEL<sup>1</sup>, JORDI MARCÉ-NOGUÉ<sup>2</sup>, THOMAS M. KAISER<sup>2</sup>, ROBERT J. BROCKLEHURST<sup>1</sup> and WILLIAM I. SELLERS<sup>1</sup>

<sup>1</sup>School of Earth and Environmental Sciences, University of Manchester, <sup>2</sup>Centrum für Naturkunde, Universität Hamburg

Primates have been frequently interpreted to be adapted to fruit consumption, even though some groups show clear adaptations to other dietary habits. Pitheciids stand out for showing clear crano-mandibular modifications to specifically predate seeds. This specialization is known as sclerocarp and it refers to the extraction of seeds using the anterior dentition followed by the mastication of seeds. It has been proposed that Callicebus–Pithecia–Chirotopes–Cacajao represent a morphocline of increasingly specialized anatomical traits for sclerocarpic foraging, although this has not been quantitatively tested for the mandible. The present study tried to address if there actually is a sclerocarpic specialization continuum in the mandibular morphology of the pitheciids, as well as to test whether their mandibular shape is associated with the percentage of seeds in their diet and/or biomechanical performance. Finite Element Analysis (FEA) was used to simulate two biting scenarios and the obtained stress distributions were compared between the different pitheciid genera using a statistical approach. Geometric Morphometric (GM) were used to test the association between mandibular shape and the percentage of seeds consumed by each species and the stress values obtained from the FEA simulations. The results showed that there is an association between mandibular shape and the percentage of seeds in diet in the top-ranked month. This study has shown that a combined approach using GM and FEA was able to cast some light regarding the morpho-functional consequences of seed predation, thus contributing to a better insight of the association between mandibular form and function.

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### Are human voices honest signals of condition?

DAVID A. PUTS

Center for Brain, Behavior, and Cognition; Center for Human Evolution and Diversity; Department of Anthropology, Pennsylvania State University

Humans are an intensely vocal species, but our voices convey more than linguistic content. In particular, human voices may have evolved in part to signal condition to competitors and potential mates. Here I review anatomical, endocrine, and behavioral evidence that men's and women's voices provide information to competitors and potential mates about the vocalizer's condition. This evidence suggests that men's voices convey information about aggressive potential, formidability, immune function, and developmental stability. By contrast, women's voices convey information about fecundability across the ovulatory cycle and lifespan, as well as developmental stability. I then present laboratory evidence from human studies and cross-species evidence from anthropoid primates that the most perceptually salient acoustic parameter, fundamental frequency, has been shaped by intrasexual and intersexual selection, perhaps initially as a (partly) deceptive signal of male size. I conclude by considering how our voices inform us more generally about the mechanisms and intensity of human sexual selection.

### Functional Neuroimaging Insights into Acheulian Cognition and Hominin Brain Evolution

SHELBY S. PUTT<sup>1</sup>, SOBANAWARTINY WIJAEKUMAR<sup>2</sup>, ROBERT G. FRANCISCUS<sup>3</sup> and JOHN P. SPENCER<sup>2</sup>

<sup>1</sup>Center for Research into the Anthropological Foundations of Technology, The Stone Age Institute, <sup>2</sup>School of Psychology, University of East Anglia, <sup>3</sup>Department of Anthropology, University of Iowa

After more than 800,000 years of making simple Oldowan flake and pebble tools, the adoption of Acheulian handaxes by early *Homo* in the Early Stone Age is thought to represent an evolutionary change in hominin cognition. The present study uses a neuroarchaeological approach to test the hypothesis that Acheulian toolmaking recruits higher-order cognition areas of the brain to a greater extent than Oldowan toolmaking. Functional near-infrared spectroscopy (fNIRS) was used to measure the brain activity of 31 right-handed, adult, human participants as they made replicative Oldowan and Acheulian stone tools, after receiving seven hours of training. The optic signals for the two knapping tasks were processed to produce functional images of the brain that were analyzed using ANOVA. The knapping tasks were then compared to a motor baseline task with Wilcoxon signed-rank tests to exclude any general motor areas that are involved in stone knapping. Results reveal

that Acheulian tool manufacture requires the integration of multimodal information and the guidance of visual working memory representations to accomplish higher-order motor planning than what is necessary for Oldowan tool manufacture. Interestingly, this Acheulian cognitive network is nearly identical to one that comes online when trained pianists play the piano, which is consistent with this network being critical for audiomotor integration when monitoring one's performance during a complex task. Selection for this cognitive network around 1.8 Ma marked a turning point in the evolution of the hominin brain, potentially leading to larger brain size and to the appearance of more complex, human-like behaviors.

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### Paleopathological Assessment of Health and Social Status in a Texas Gulf Coastal Plains Population

JUSTIN A. PYLE, COURTNEY C. SIEGERT and MICHELLE D. HAMILTON

Anthropology, Texas State University

The Mitchell Ridge site (41GV66) is located in Galveston County, Texas, and was occupied from the Late Archaic into the Early Historic Period. Previous research highlights differences in grave goods from two areas at the site, and this has been inferred to indicate a socially stratified society. Social stratification may be observable via paleopathological indicators, since disparities in health can be associated with differential access to resources between higher and lower status individuals. This study investigates the presence of a social hierarchy by examining the skeletal remains for the presence/absence of bone lesions. Individuals in the study consisted of primary and secondary inhumations spanning the prehistoric to historic periods. Twenty total individuals were analyzed for the presence/absence of trauma and pathological indicators of non-specific stress including dental caries, enamel amelogenesis, periodontitis, dental abscesses, periodontitis, cribra orbitalia, ectocranial porosity, and osteoarthritis. This information was compared with burial area, grave good presence, burial type, demography, and temporal component. Statistical analysis indicates no significant difference in pathologies between the two burial areas; however, there is a significant difference in grave goods in these areas. Therefore, the association between pathology and grave goods was explored, revealing no significance. Next, no association was found between burial type and pathology, or sex and pathology. Finally, no significant association with temporal component and pathology exists. While this population may

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be socially stratified, the pathological data did not support this, and these results may indicate a change in burial practices over time, and not necessarily social stratification.

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### Family isn't everything: Strontium and oxygen stable isotope analysis of a known population from Fewston Parish, UK

LESLIE QUADE, REBECCA GOWLAND and ANDREW MILLARD

Archaeology, Durham University

Stable isotope analyses are an important and increasing presence in biological anthropological research. However, many aspects of isotopic analyses are not yet fully understood. This study investigates the variation in strontium and oxygen isotopic ratios of a known local population within the cemetery of the Church of St Michael and St Lawrence, Fewston. The identities of 10 individuals were ascertained from a combination of coffin plates, burial monuments and historical sources, and included three separate sets of direct siblings; the first comparison of its kind. This analysis creates an opportunity to examine how strontium and oxygen isotopic ratios vary within a local community and between siblings, impacting how interpretations about unknown individuals are formed. Results yielded a wider range of  $^{87}\text{Sr}/^{86}\text{Sr}$  and  $\delta^{18}\text{O}_p$  values than was originally hypothesized for a remote rural community. Additionally surprising were the differences between the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios amongst the pairs of siblings. Further analysis of the data organized by chronology of birth, revealed that surrounding socioeconomic conditions may have impacted the  $^{87}\text{Sr}/^{86}\text{Sr}$  values more than familial food preparation techniques and relationships. By contrast, oxygen isotope values appear to show that family habits may have played a stronger role amongst the community. This study adds to the growing body of research, indicating that the uptake of strontium and oxygen isotopes is mitigated by many complex factors, both biological and cultural, requiring further investigation and highlights the need for caution in the analysis of data with less available contextual information.

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### Steele: An Examination of Early Archaic Cremations from Southern Indiana

ROBIN QUATAERT<sup>1</sup>, CHRISTOPHER W. SCHMIDT<sup>2</sup> and CURTIS TOMAK<sup>2</sup>

<sup>1</sup>Anthropology, State University of New York, University at Buffalo, <sup>2</sup>Anthropology, University of Indianapolis

Steele is an Early Archaic period cemetery site used by the people associated with the Jerger phase in southern Indiana. The phase is defined by a diagnostic bifurcated base projectile point known as a Jerger point, spans between 8000-9000YBP and has a range among Greene, Daviess and Knox counties. This phase is represented by

3 cemeteries and 97 habitation/non-burial sites. This study seeks to explore the Steele site and to provide more insight into Early Archaic mortuary practices in Indiana which are currently poorly understood. This was done through the determination of an MNI, establishing a site demography, and determining the extent of burning based on color, fracture patterns, warping, delamination and cultural modifiers. The MNI of six was established via repeating dental elements. Fragments averaged 14.2mm in maximum length, which is slightly larger than that found at the nearby Jerger site. Ninety-eight percent of the bones examined were burned, of which eighty-three percent were calcined or near calcined, indicating a high temperature and extended duration of burning, which may have occurred twice. The remains are more heavily burned than most other prehistoric burials. Cremation during the Early Archaic does not appear to be a widespread practice, with only 3 known sites located in Indiana. These cemeteries show significant energy investment during the Early Archaic, and the possible establishment of corporate control in this region.

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### The role of FZD6 in the evolution of tanning response in the Americas

ELLEN E. QUILLEN<sup>1</sup>, JAYDEE FOSTER<sup>1</sup>, ANNE SHELDRAKE<sup>1</sup>, NINA G. JABLONSKI<sup>2</sup> and MARK D. SHRIVER<sup>2</sup>

<sup>1</sup>Department of Genetics, Texas Biomedical Research Institute, <sup>2</sup>Department of Anthropology, Pennsylvania State University

Facultative pigmentation, the result of impermanent changes in skin color in response to ultraviolet radiation from the sun, is an essential but poorly understood component of the evolution of skin color. Based on early research in predominantly European populations, increased tanning capacity has long been attributed predominantly to individuals with relatively darker constitutive pigmentation. This pattern extends to genetic research where genome-wide studies of facultative pigmentation have considered European and Asian populations but none have included populations of the Americas. Diversifying our understanding of the genetic underpinnings of tanning to include populations of the Americas is essential as dermatological evidence suggests decoupling of constitutive and facultative pigmentation among these populations.

We have recently identified several genes associated with increased tanning response and persistence among 91 Mexican Americans with Indigenous American ancestry who received controlled UVR exposures on naïve skin. The strongest of these associations ( $p = 1E-7$ ) are in the gene *FZD6* which has previously been linked to hair patterning. Analysis of integrated haplotype scores (iHS) in HapMap populations indicates weak selective pressure at this locus in East Asian populations with scores ranging from 2.5

to 3. We are in the process of evaluating evidence for selection at *FZD6* among populations of the Americas for which little data is currently available. Identifying and evaluating the evidence of selection on genes that influence constitutive and facultative pigmentation will allow us to better understand this potential source of convergent evolution as early humans faced the old challenge of UVR in new environments.

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### Oxygen isotopic correlates of diet and drinking behavior in extant mammals from Laikipia, Kenya: implications for gauging Pliocene Turkana hominin paleoecology

RHONDA QUINN<sup>1,2</sup>, CHRISTINA RYDER<sup>3</sup>, JASON LEWIS<sup>4</sup>, BRIANA POBINER<sup>5</sup> and OGETO MWEBI<sup>6</sup>

<sup>1</sup>Sociology, Anthropology & Social Work, Seton Hall University, <sup>2</sup>Department of Earth and Planetary Sciences, Rutgers University, <sup>3</sup>MA Program in Human Skeletal Biology, Department of Anthropology, New York University, <sup>4</sup>Department of Anthropology & Turkana Basin Institute, Stony Brook University, <sup>5</sup>Human Origins Program, Department of Anthropology, Smithsonian Institution, <sup>6</sup>Department of Osteology, National Museums of Kenya

Evidence for tool use and  $C_4$  resource dietary inputs circa 4-3 Ma may suggest a trophic level shift toward increasing consumption of animal meat and marrow prior to the fossil record of genus *Homo*. In mammals, obligate drinkers typically achieve lower  $d^{18}\text{O}_{\text{EC}}$  (enamel carbonate) values than non-obligate drinkers. It has been shown in South African extant and fossil ecosystems that  $d^{18}\text{O}_{\text{EC}}$  values are lower in carnivores relative to herbivores and may be useful as a potential indicator of meat consumption in fossil hominins. In this study we analyze  $d^{18}\text{O}_{\text{EC}}$  values of extant mammals (species  $n = 24$ ; total  $n = 62$ ) from the Laikipia District, Kenya. Environments encompass grassy woodlands and wooded grasslands, contain a large perennial river system, and thus serve as analogous contexts to Pliocene Turkana. We increase the sample size of reported  $d^{18}\text{O}_{\text{EC}}$  values of herbivores and omnivores from Laikipia and characterize additional species (gerenuk, steinbok, reedbuck, giant forest hog). We also analyze several carnivores (lion, leopard, cheetah, serval cat, spotted hyena, and wild dog). Obligate drinkers (OD) show lower  $d^{18}\text{O}_{\text{EC}}$  values than non-obligate drinkers (ND) and are comparable to local river  $d^{18}\text{O}$  values. Carnivores have significantly lower  $d^{18}\text{O}_{\text{EC}}$  values than herbivores. OD browsers yield lower  $d^{18}\text{O}_{\text{EC}}$  values than OD grazers. Omnivores show the largest range of  $d^{18}\text{O}_{\text{EC}}$  values, but this may be the result of habitat-related dietary differences. We compare Laikipia data to all published faunal  $d^{18}\text{O}_{\text{EC}}$  values from the Turkana Basin and discuss plausible interpretations of Turkana hominin diets and drinking behaviors.

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## Genome Variation across the Bantu to Nilo-Saharan Linguistic Boundary in Uganda

RYAN L. RAAUM<sup>1,2</sup> and DAN ISABIRYE<sup>3</sup>

<sup>1</sup>Anthropology, Lehman College / CUNY, <sup>2</sup>New York Consortium in Evolutionary Primatology, (NYCEP),

<sup>3</sup>Biochemistry and Sports Science, Makerere University

The current distribution of human genetic variation in Central, Eastern, and Southern Africa is largely the result of two major expansions that occurred within the last few thousand years: the movement of Bantu speakers south and east from the Nigeria-Cameroon border area and the movement of Nilo-Saharan speakers south from the eastern Sahel. These two migrations halted each other in north-central Uganda, with Nilo-Saharan speakers living north and east of the linguistic boundary and Bantu speakers living south and west. Archaeological data clearly shows that there were established populations in Uganda prior to these relatively recent migrations and linguistic analysis suggests that at least some of them were Afro-Asiatic speakers. Were these earlier populations displaced by the Bantu and Nilo-Saharan speakers or were they absorbed? We recruited project participants from four ethnic groups in eastern and north-eastern Uganda: Iteso (Nilo-Saharan speakers), Ik (Nilo-Saharan speakers), Bagisu (Bantu speakers), and Benet [Sabiny] (Bantu speakers). We collected saliva samples, extracted DNA, and obtained genome-wide SNP genotype data using the Illumina beadchip platform. After quality control, we merged our new data with comparable published data from populations in southwestern Uganda, Sudan, Ethiopia, Kenya, Tanzania, and elsewhere in Africa. Analyses of these data using population clustering, *f*-statistics, and graph models reveals small proportions of ancestry distinctly different from that typically found in Bantu and Nilo-Saharan speakers. Therefore, while there may have been displacement as well, at least some earlier Ugandan populations were absorbed by the Bantu and Nilo-Saharan speakers.

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## The relationship between the soft pink things and the hard white things

KARYNE N. RABEY<sup>1</sup>, RUSSELL MOSKAL<sup>1</sup>, KEVIN G. HATALA<sup>2,3</sup> and ERIN MARIE WILLIAMS-HATALA<sup>2,3</sup>

<sup>1</sup>Department of Anatomy, Midwestern University,

<sup>2</sup>Department of Biology, Chatham University, <sup>3</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University

Behavioural and health patterns of past populations are often inferred from the morphologies of bones. In the past, studies have used the sizes and shapes of entheses for functional interpretations. However, the validity of these interpretations is uncertain. A more complete understanding of how bone and muscle interact continuously over the course of life is essential for using such methods to infer past behaviours. The goal of our research is to observe the relationships between behaviour, muscles and their attachments to see what can actually be inferred from their morphology.

Here we test the hypothesis that behaviour and/or age will correlate with aspects of muscular and enthesal morphology. Both an animal model (mice, *n* = 50) and human cadavers (*n* = 24) were studied. Activities of the mice (control, wheel running, cage climbing) were monitored and ages of all samples were recorded. Muscle architectural data (e.g., mass, fibre length, PCSA) and histological data (e.g., fibre type) were recorded. Surface measurements of entheses (e.g., size and shape) and data on bone microstructure underlying the entheses (e.g., trabecular and cortical density) was also collected. In mice, behaviour and age correlate strongly with muscle data (muscle atrophy, changes in fibre type distribution with different activity and increased age). However, neither model showed any clear relationships between muscular and enthesal morphology. This research continues to demonstrate that despite the functional plasticity of muscle tissue, entheses are less predictable and their surface appearance should not be used to make behavioural inferences from past populations.

## What we know (and don't) about human sinus variation and climate

TODD C. RAE<sup>1</sup>, LAURA T. BUCK<sup>2,3</sup> and THOMAS KOPPE<sup>4</sup>

<sup>1</sup>Department of Life Sciences, University of Roehampton, <sup>2</sup>Department of Archaeology, University of Cambridge, <sup>3</sup>Department of Palaeontology, Natural History Museum, <sup>4</sup>Institut für Anatomie und Zellbiologie, Universitätsmedizin Greifswald

Speculation about the relationship between paranasal pneumatization and climate has existed for decades. Spurred by the belief that *Homo neanderthalensis* had relatively large sinuses, and by the fact that this species' habitat (Eurasia) underwent severe periodic cooling during the Pleistocene, hyperpneumaticity was added to the list of traits suggesting cold adaptation.

Empirical evidence from extant hominins, other primates and other mammals, however, demonstrates exactly the opposite. Within populations/species, individuals raised in very cold environments tend to have smaller paranasal sinuses. The relationship holds in both natural and

experimental contexts. The fact that neanderthal sinuses are not relatively smaller than temperate climate European people implies that *H. neanderthalensis* was not subjected to cold stress.

More recently, doubt has been cast on this interpretation, based on the assumption that the demonstrable relationship between pneumatization and cold stress should imply a species-wide correlation between climate and sinus size in *H. sapiens*. This inference is erroneous. Results from a much broader sample of *H. sapiens* confirm that there is no overall trend, nor would we necessarily expect a species with a complicated history of dispersal and gene flow within and between populations to show such a relationship. This fact, however, does not contradict the findings that very low ambient temperatures affect sinus size, whether indirectly or otherwise, and that a lack of discernable reduction in the volume of craniofacial pneumatization can be taken as evidence of a similar absence of cold stress.

## Communicating early career research: The importance of outreach

JENNIFER A. RAFF

Anthropology, University of Kansas

Much is currently demanded of early career scholars, including developing an independent research program, securing funding, developing collaborations, teaching, mentoring, and publishing high quality papers. In this context, the addition of any activities that are not traditionally valued by hiring and tenure committees—like public outreach—is often stigmatized as frivolous or a waste of time. But in the current social and political climate, issues such as race, gender, evolution, and conservation dominate public discourse and the expert voices of biological anthropologists are crucially needed. Achieving a balance between traditional expectations and newer outreach efforts can actually be easier for early career scholars than more established academics, and can help immensely in diversifying the field.

This presentation will highlight why research communication—to both specialists and non-specialists—is a core professional skill that needs to be emphasized in training the next generation of biological anthropologists. I argue that some outreach efforts need to be valued as scholarly activities by tenure and promotion committees. The costs and benefits of different outreach methodologies currently utilized by early career scholars in biological anthropology will be discussed (e.g., social media use, long-form writing for the general public, podcasting), and strategies for integrating research communication training into graduate courses will be proposed.

## ABSTRACTS

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### Ontogenetic changes in trabecular architecture: A pilot study of chimpanzee (*Pan troglodytes*) manual and pedal elements

ANNA J. RAGNI<sup>1,2,3</sup>, NICOLE WEBB<sup>3,4,5</sup> and WILL HARCOURT-SMITH<sup>1,3,4,5</sup>

<sup>1</sup>Division of Paleontology, American Museum of Natural History, <sup>2</sup>Richard Gilder Graduate School, American Museum of Natural History, <sup>3</sup>New York Consortium in Evolutionary Primatology, <sup>4</sup>Department of Anthropology, Lehman College, <sup>5</sup>Department of Anthropology, The Graduate Center, CUNY

Trabecular bone is argued to be functionally informative and responsive to differences associated with locomotion. While external morphology may indicate what an individual was capable of doing, the internal trabeculae speaks to nuances relating to actual loading behavior. These nuances may change throughout ontogeny, as chimpanzees (*Pan troglodytes*) are known to move more arboreally as juveniles and terrestrially as knuckle-walking adults. Using an established skeletal growth series of *P. troglodytes* allows for the assessment of trabecular changes between hands and feet. We report results from analyses of trabeculae in manual and pedal elements (capitate and lateral cuneiform) important in locomotion-related force transmission through ontogeny for *P. troglodytes*, using six standard age groups.

Volumes of interest within each bone were mCT scanned at ~40mm resolution and scaled to 50 percent of the maximum mediolateral breadth of each bone. Despite a small sample size, the size-corrected results indicate age-based trends in anisotropy (DA), bone surface area/bone volume (BS/BV), and bone volume/total volume (BV/TV), with clearer trends apparent in the capitate. In line with expectations of more uniform foot use across age groups, the BV/TV of the lateral cuneiform does not change with age, while the capitate shows a general decrease through ontogeny, which may relate to the increased compressive forces applied to the wrist in adulthood. These differences confirm known ontogenetic locomotor behavior differences in relation to both the hand and foot, and demonstrate the potential of using trabecular bone as a proxy to better understand the ontogeny of fossil hominin locomotion.

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### Population continuity and replacement in the pre-contact Valley of Mexico

COREY S. RAGSDALE<sup>1</sup> and HEATHER J.H. EDGAR<sup>2</sup>

<sup>1</sup>Department of Anthropology, Southern Illinois University Edwardsville, <sup>2</sup>Department of Anthropology, University of New Mexico

Settlement patterns in the pre-contact period Valley of Mexico are often characterized by the collapse and regeneration of civilizations, creating a series of power vacuums over time. This can be seen with the rise and decline of Teotihuacán

in the Classic period (AD 200-900), followed by the Toltecs at Tula in the Early Postclassic period (AD 900-1200) and the Aztecs in the Late Postclassic period (AD 1200-1520). How did these abrupt political changes affect the population structure of groups throughout the region? Can population structure in the Valley of Mexico be best characterized as population replacement, population continuity, or both? To address these questions, we compared biological distances based on dental morphological observations with models representing population continuity and replacement among samples representing Valley of Mexico populations from Preclassic (1200 BC to AD 200) Tlatilco to Late Postclassic Aztec settlements. We used Mantel and partial Mantel tests and multidimensional scaling to compare biological distances and distances derived from archaeological and ethnohistoric data. Our results support the population replacement model in the Valley of Mexico, confirming archaeological and ethnohistoric accounts of migration patterns. We conclude that population replacement is much more evident during the transition from the Classic to Postclassic periods, during a time known as the Epiclassic period (AD 600-900), and throughout the Postclassic period. This study provides biological support for population replacement events occurring during the rise and fall of great polities such as Teotihuacán and Tula, and the subsequent rise of the Aztecs.

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### Evidence of Coastal New Guinea Population Geneflow and Implications for the Southern and East Asian Migration Route Hypotheses

SARAH RAGSDALE<sup>1</sup> and HANNAH MARSH<sup>2</sup>

<sup>1</sup>Anthropology, University of Kansas, <sup>2</sup>Anthropology, University of Central Missouri

Genomic analyses of coastal New Guinea populations indicate both the Southern and Out of East Asia migration routes are important to the island's settlement and recent geneflow. The mtDNA lineages found in individuals living in the Bismarck and Admiralty archipelagos are not typically observed on mainland New Guinea, suggesting a distinct ancestry originating in Southeast Asia. Evidence exists supporting both migration hypotheses, such as the division and expansion of Austronesian and non-Austronesian languages, the Lapita culture movement, and Denisovan ancestry placing New Guinea at an essential location for understanding human migrations across Oceania. 288 Southeast Asian and Melanesian mtDNA genomes collected from GenBank were used to compute genetic distances between populations and construct a neighbor-joining phylogenetic tree using MEGA version 7.0 freeware. The results exhibit close genetic affinities among mainland and archipelago New Guinea to the islands along the initial southern route including Java, Sulawesi, and

Borneo, suggesting a common founding lineage. However, high differentiation is seen between the New Guinea mainland and archipelago populations, reflected in significant *F<sub>st</sub>* values, indicating a potential secondary migration from East Asia, introducing new genetic variation into the eastern archipelago populations. As the proposed second migration traveled further from Southeast Asia and into Remote Oceania, genetic distances began to increase between these populations and mainland New Guinea, whereas distances have decreased between Remote Oceanians, specifically, the Solomons, Vanuatu, Fiji, and the New Guinea archipelagos, thereby further diversifying populations of mainland New Guinea from those of the Bismarck and Admiralty archipelagos.

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### Histological indicators of stress

EMELINE RAGUIN<sup>1</sup>, MARGARET A. STREETER<sup>2</sup> and MICHELLE S.M. DRAPEAU<sup>1</sup>

<sup>1</sup>Department of Anthropology, Université de Montréal,

<sup>2</sup>Department of Anthropology, Boise State University

The process of bone remodeling produces several morphological types of osteons. In addition to the common or Type I osteon and the drifting osteon, two other forms of remodeling, Type II and zonal osteons, have been observed. Numerous studies have investigated the relationship between these two forms of remodeling and nonspecific stress but a consensus has not been reached. The Type II osteon displays two scalloped reversal lines, one within the other, suggesting that an area of bone along the Haversian canal has been resorbed and filled in again. It has been hypothesized as a possible sign of active mineral exchange that would be more prevalent in unhealthy individuals. The purpose of this study is to test whether Type II osteons correlate with evidence of macroscopic pathologies. The sample consists of tibias (n=26; 9 females, 17 males) of Eurocanadians from the historical St. Matthews cemetery in Quebec city, Quebec. These individuals displayed a number of skeletally identifiable gross pathologies, such as metabolic disease, degenerative joint disease and traumas.

In order to explore the possible physiological differences due to sex, males and females were compared using a Mann Whitney U test, but no difference was found (p=0,169). The sample was then pooled to test whether individuals presenting gross pathologies had a greater number of Type II osteons than individuals without apparent pathologies. Again, no difference was noted (p=0,659). These preliminary results suggest that there is no correlation between Type II osteons and skeletally observable pathologies.

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## Objectively measured physical activity in a hunting and gathering population

DAVID A. RAICHLIN<sup>1</sup>, HERMAN PONTZER<sup>2,3</sup>, JACOB A. HARRIS<sup>4</sup>, THEODORE W. ZDERIC<sup>5</sup>, MARC T. HAMILTON<sup>6</sup> and BRIAN M. WOOD<sup>6</sup>

<sup>1</sup>School of Anthropology, University of Arizona,

<sup>2</sup>Department of Anthropology, Hunter College, <sup>3</sup>New York Consortium for Evolutionary Primatology,

<sup>4</sup>School of Human Evolution and Social Change, Arizona State University, <sup>5</sup>Texas Obesity Research Center, University of Houston, <sup>6</sup>Department of Anthropology, Yale University

Researchers have long suggested that human physiological requirements for aerobic exercise reflect an evolutionary shift to a hunting and gathering foraging strategy and the transition to more sedentary lifestyles likely represents a physical activity (PA) mismatch with our past. Recent objective measures of activity and energy expenditure present a more nuanced picture of PA in foraging societies, and suggest that groups practicing traditional subsistence may have PA levels within the range of more developed societies. Here, we used ActivPal thigh-worn accelerometers to objectively measure PA in a group of hunter-gatherers (the Hadza of northern Tanzania) who we have previously shown to have similar daily energy expenditures compared to individuals living in industrialized societies. Twenty-eight Hadza participants (n=16M, n=12F, ages: 18-61) wore ActivPals for eight days. We found high levels of PA overall, with individuals spending an average of 78.57±9.21 minutes/day in moderate-to-vigorous physical activity (MVPA; measured in 10-minute continuous bouts), exceeding US government recommendations for health maintenance. Sex and age did not have a significant effect on time spent in MVPA (Sex: p=0.21, Age: p=0.13, Sex\*Age: p=0.40). Finally, we found a significant negative relationship between time spent in MVPA and time spent sedentary (r=0.80, p<0.001). This result differs from studies of industrialized populations, where time spent in MVPA has no significant effect on time spent sitting. Our study will help us reconstruct levels of activity in our evolutionary past, place modern levels of PA into a comparative context, and help us understand the relationship between PA and energetics.

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## Intrinsic Manual Proportions affect the Biomechanics of Suspension

KRISTEN R. RAMIREZ<sup>1,2</sup> and HERMAN PONTZER<sup>1,2,3</sup>

<sup>1</sup>Anthropology, CUNY Graduate Center, <sup>2</sup>NYCEP, New York Consortium in Evolutionary Primatology,

<sup>3</sup>Anthropology, Hunter College, CUNY

Extant non-human hominoids share a suite of postcranial features associated with suspensory behaviors including: elongated manual elements,

a high upper to lower limb ratio, and a relatively short lumbar column. However, the influence of hominoid body shape and more specifically hand shape on suspensory performance has not been empirically tested, nor have the dynamics of the hand-substrate contact been calculated. Here we test the suggested form-function relationship between hominoid hand proportions and suspensory performance. Human subjects manually grasped bars of varying diameters fitted with pressure sensors. We used the pressure sensor data to calculate the normal force around the hand-substrate contact. We designed the bars to deform with the rotational force (moment), and calculated the degree of deformation from coordinate kinematic data. Results show that normal forces are greatest proximally (palm). However, forces increase at the distal phalanges as hand length increases relative to substrate circumference. These results are consistent with osteological analyses showing that in hominoids each manual segment is relatively short compared with the element immediately proximal. This negative allometry in element length along the rays minimizes phalangeal force distally by reducing the hand length:substrate circumference ratio. Further, the relatively long metacarpals in rays 2-5 of hominoids may be a response to the higher forces experienced nearer the palm during suspension from large diameter branches. In short, hominoids display relatively long metacarpals and short phalanges that minimize forces distally. These findings have implications for identifying suspensory behaviors in fossil Miocene hominoids, and retained arboreality in Pliocene hominins.

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## Trabecular symmetry in the primate temporomandibular joint

PATRICIA A. RAMOS<sup>1</sup>, ADAM D. SYLVESTER<sup>2</sup>, ANDREA B. TAYLOR<sup>3</sup> and CLAIRE E. TERHUNE<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Arkansas,

<sup>2</sup>Center for Functional Anatomy and Evolution, Johns Hopkins School of Medicine, <sup>3</sup>Department of Basic Science, Touro University

The loading environment of the temporomandibular joint (TMJ) varies in relation to feeding behavior, pathological conditions, and between working and balancing sides. Since bony morphology responds to these forces via bone functional adaptation (i.e., Wolff's Law), both external and internal structure of the joint should vary in relation to these factors. Most previous work in nonhuman primates has assessed the link between internal architecture of the TMJ and diet. Here, we present a preliminary analysis of trabecular architecture of the TMJ in relation to pathology and symmetry.

We examine microCT scans of 12 sooty mangabey (*Cercocebus atys*, 6 male/6 female) crania, which show varying severity of osteoarthritis. We assess trabecular architecture by using sliding semilandmarks to locate multiple VOIs across the condylar articular surface, and quantify trabecular architecture (e.g., thickness, spacing, anisotropy, and bone volume fraction) in each VOI using BoneJ. Heat maps were employed to visualize patterns of trabecular variables between left and right sides.

Results indicate that, although there are differences between left and right sides within an individual, there is no consistent pattern of differences in trabecular properties across the sample. However, individuals with signs of TMJ osteoarthritis show more variability in our measures of trabecular architecture between left and right condyles. These results indicate that loading environment may differ between left and right sides more substantially for pathological individuals than for those unaffected by pathology of the TMJ. These findings have implications for further understanding bone plasticity outside of variation related to feeding behavior.

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## Beyond the exclusive presence of *Treponema* and *Bifidobacterium* in the gut microbiota of hunter-gatherers and Western populations: new insights in microbes-host co-evolution

SIMONE RAMPELLI, SILVIA TURRONI and MARCO CANDELA

Department of Pharmacy and Biotechnology, University of Bologna

The gut microbiota (GM) have changed their phylogenetic and functional configuration in response to the different subsistence strategies along the course of human evolutionary and ontogenetic history. The GMs of Western industrial populations is characterized by an overall reduction in biodiversity, loss of *Treponema*, and the presence of *Bifidobacterium* as an abundant component of the post-weaning GM ecosystem. In order to shed light on the possible adaptive nature of this exchange, we demonstrated specific functional attributes that correspond to the mutually exclusive presence of *Treponema* and *Bifidobacterium* in 27 Hadza hunter-gatherers from Tanzania and 11 urban industrial Italians by shotgun metagenomics. The comparison of their GM layout represents a unique opportunity to highlight the variation of GM-host symbiosis, illustrative of two contrasting modes of subsistence from hunting and gathering to a Western lifestyle, and may inform about GM-host co-evolutionary events. This research shows that *Bifidobacterium* contribute to the metabolic capability of Western GMs by providing diverse saccharolytic functions that are well suited to

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the gluco- and galacto-based saccharides of the Western diet. On the other hand, the genes detected for *Treponema* are indicative of complex polysaccharide metabolism, such as those found in unrefined plant foods present in the Hadza diet. Finally, unlike *Treponema*, the *Bifidobacterium* metagenome include genes that permit the establishment of microbe–host immunological cross-talk, suggesting recent co-evolutionary events between the human immune system and *Bifidobacterium* that are adaptive in the context of agricultural subsistence and sedentary societies.

### Quantifying *Microcebus* Habitat Loss Due to Roads

MALCOLM S. RAMSAY<sup>1,2</sup>, ANDRIAMAHERY RAZAFINDRAKOTO<sup>3</sup>, HAJANIRINA N. RAVELONJANAHARY<sup>4</sup> and SHAWN M. LEHMAN<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Toronto,

<sup>2</sup>School of the Environment, University of Toronto,

<sup>3</sup>Département de Biologie Animale, Université D'Antananarivo, <sup>4</sup>Département de Biologie et Ecologie végétales, Université D'Antananarivo

Roads can negatively impact animals by removing habitat and altering roadside habitat conditions. Habitat loss is three-dimensional as roads must be maintained and vegetation subdued to allow the movement of large vehicles. Mouse lemurs (*Microcebus* spp.) are an ideal genus to understand the impact of roads on vertical animal habitat as small-bodied (30–70 g) arboreal primates. In order to assess habitat loss for mouse lemurs, we conducted our study in Ankarafantsika National Park (ANP) in Madagascar, a park that is bisected by a paved national highway, Route National #4 (RN4). We conducted a capture-mark-recapture study to assess mouse lemur movement. Additionally, vegetation plots of 4x4m were set up at 40 sites in three locations (n=120); two along RN4 and one within the interior forest to assess roadside habitat conditions. Lastly, using the Gautier method we assessed three-dimensional canopy loss on RN4. Mouse lemurs were significantly inhibited in their movement in roadside habitat compared with the interior forest. Interior forest habitat contained a significantly greater portion of vegetation in the shrub layer (0.5–2.9 m), all other roadside habitat variables did not differ between locations. Additionally, as a result of road construction, we calculated a loss of 248 vertical canopy sites, belonging to 44 plant species along a 400 m section of RN4. These results suggest that the inhibition of movement in mouse lemurs along RN4 is due to a loss of lower canopy. Overall, road construction cannot be overlooked as a serious concern for conservation biologists in Madagascar and beyond.

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### The Environmental Sulfur Isotope Composition of the Maya Region: A working Model and Preliminary Results

ASTA J. RAND and VAUGHAN GRIMES  
Archaeology, Memorial University of Newfoundland

The analysis of stable sulfur isotopes from bone collagen offers researchers a novel technique for distinguishing dietary protein from various environments (i.e., marine, freshwater or terrestrial) and identifying nonlocal individuals in archaeological samples. This is possible because the sulphur isotope composition of the local environment is incorporated into the tissues of consumers and will, therefore, reflect the area in which their dietary resources were obtained. However, the sulfur isotope composition of the environment must first be determined in order to accurately interpret the values obtained from archaeological human tissue. Here, we present the predicted sulfur isotope composition of various environments throughout the Maya region in a working model based on known sulfur isotope values from similar environments elsewhere in the world. Coastal areas are predicted to exhibit sulfur isotope values near +20‰ that are expected to decrease with increasing altitude and distance from the coast, and with increasing input from terrestrial sulfur sources. The model is supported by preliminary sulfur data from one Preclassic and 12 Classic human bone samples from the Maya site of Caledonia, Cayo District, Belize, which are consistent with the sulfur values predicted for the local environment. Analyses of archaeological faunal remains from multiple sites throughout the Maya region will further test the environmental values predicted in the model. Once confirmed, such a model will not only contribute to understandings of prehispanic Maya diet and movement but will also provide a method by which similar models in other regions may be developed in the future.

Social Sciences and Humanities Research Council of Canada, Canadian Association of Physical Anthropology, Memorial University of Newfoundland

### Outreach initiatives related with health, obesity and osteology developed by the Anthropological Museum Montané in elementary schools and communities of Cuba

ARMANDO RANGEL, VANESSA VÁZQUEZ, DULCE MILAGROS NIEBLA and MARÍA ELENA DÍAZ  
ANTHROPOLOGICAL MUSEUM MONTANE,  
UNIVERSITY OF HAVANA

The aim of the paper is to describe the initiatives of outreach developed by researchers of the Anthropological Museum Montané, Faculty of Biology, University of Havana, in collaboration with the Faculty of Philosophy and History and the National Institute of Hygiene, Epidemiology and Microbiology. Two of the projects "Of the

hand of Martí we learn how to take care our health", and "Representations and beliefs on obesity in Cuba", have as objectives the promotion of health with the thoughts of Cuban national Hero's José Martí and prevention of child obesity. The nutritional status of 461 students from 9 to 12 years of 4 elementary schools of Havana was evaluated. The 30 % has overweight or obesity. Also, questionnaires have been applied to the students with variables of lifestyle and educative discussion groups and interviews have been developed with their relatives on topics such as feeding and obesity. The other project is titled "Local development and education on heritage and archaeology in the community La Picadora, municipality Yaguajay, Sancti Spiritus province". The researchers of the museum have offered conferences to the residents of this rural community on topics related with heritage and archaeology of the area and they identified the human aboriginal bones remains found in the cave La Vigía, near the town. This way, the outreach initiatives on topics of interest for physical Anthropology such as health, obesity and osteology were done in order to the well-being of children, families and members of communities

### Diploic patterns and vascular morphometrics in fossil specimens

GIZEH RANGEL DE LAZARO<sup>1</sup> and EMILIANO BRUNER<sup>2</sup>

<sup>1</sup>Departamento de Historia e Historia del Arte, Universitat Rovira i Virgili. Universidad de La Habana, <sup>2</sup>Paleoneurobiología de Homínidos, Centro Nacional de Investigación sobre la Evolución Humana

Diploic channels (DC) are bony passages of diploic vessels, running within cranial bones. These vessels could play a major role in brain thermoregulation, allowing bidirectional blood flow. They appear to be more developed in modern humans than in other primates or fossil hominids, suggesting evolutionary variations in our species. DC can be investigated in fossils specimens through computed tomography and digital anatomy. We reconstruct and discuss vascular morphology in seven specimens, namely Saccopastore 1, Spy 1, Spy 2, Skhul V, Steinheim, Broken Hill and Mladec 1. We describe the vascular networks, providing quantitative comparison of compact bone and cancellous bone thickness, branch length, lumen size, asymmetries and distribution of DC. Saccopastore 1 displays thicker bones than the other specimens. Spy 1 and 2 show noticeable vascular development in the parietal bones, although less expanded than modern humans. Skhul V displays thin bones and reduced vascular network. In Steinheim and Broken Hill, channels are difficult to recognize. Mladec 1 presents a vascular development similar to Saccopastore 1, Spy 1 and Spy 2. Major limits when working with fossil specimens and DC concern the degree

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of conservation of the specimen, infiltration of geological matrix into the diploe, and presence of fractures which can be confused with vascular passages. Limits in sample size hamper robust statistical approaches, mostly when considering that intra-specific variation in vascular morphology is noticeable. When compared with modern humans, fossil individuals display thicker or comparable diploic thickness, but generally less vascularized bones, suggesting independent factors for osteogenesis and vasculogenesis.

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### Effect of periodontal ligament on stress gradients in alveolar bone

ANDREW RAPOFF<sup>1</sup>, DIMA YANKOVA<sup>1</sup>, W. SCOTT MCGRAW<sup>2</sup> and DAVID DAEGLING<sup>3</sup>

<sup>1</sup>Mechanical Engineering, Union College,

<sup>2</sup>Anthropology, Ohio State University, <sup>3</sup>Anthropology, University of Florida

The periodontal ligament (PDL) is integral for transference of mechanical forces from teeth to the alveolar bone during chewing, although its effect on strain in the alveolar process is not well understood. Conclusions from finite element (FE) studies of the craniofacial skeleton are contradictory as to how PDL material properties influence stress gradients in alveolar bone. To address these contradictions, we examined the sensitivity of alveolar bone stress gradients to variations in a PDL material property that reflects its compressibility (namely, its Poisson's ratio), occlusal loading conditions and tooth root taper angle. We created simplified symmetrical FE models of single-rooted tooth surrounded by a thin PDL layer with isotropic homogeneous properties. The results showed that modeling the PDL as a nearly incompressible tissue (i.e., Poisson's ratio of 0.49) and decreasing the taper angle of the tooth root (from 15° to 10°) causes significantly higher levels of stress and stress gradients in the alveolar bone. Under normal (vertical) loading conditions, the highest stresses were in the area immediately below the root apex. Under shear (transverse) loading conditions, the highest stresses were in a region below the alveolar crest. Modeling the PDL as nearly incompressible resulted in higher stresses as far as 25 PDL thicknesses away from the PDL-alveolar bone contact surface. Since soft tissues are generally accepted as incompressible, the PDL plausibly creates higher stresses and stress gradients appreciable distances from the tooth-bone interface, and FE studies that ignore an incompressible PDL may mischaracterize alveolar bone stress and strain.

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### Dietary properties, chewing patterns and cyclical loading: It's wicked hard always being tough

MATTHEW J. RAVOSA<sup>1,2,3</sup>, SUSAN COINER-COLLIER<sup>1</sup>, KEVIN R. MCABEE<sup>1</sup> and ANNIKA L. FLING<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, University of Notre Dame, <sup>2</sup>Department of Aerospace and Mechanical Engineering, University of Notre Dame, <sup>3</sup>Department of Anthropology, University of Notre Dame

An impediment to integrating comparative, experimental, ecological and paleontological findings about primate feeding behaviors is the lack of evidence about how diet affects cyclical loading. Along with high-magnitude stresses, cyclical loading is a major determinant of bone formation in the jaws. Although cyclical loading is often invoked to explain jaw robusticity in early hominins and other primates, there is a remarkable absence of key behavioral data on the dietary underpinnings of this chewing pattern. Thus, it is difficult to partition the role of high-magnitude vs. high-frequency forces on physiological and evolutionary responses in the skull.

Using *in vivo* data on representative adult strepsirrhines and haplorrhines, we test the hypothesis that food mechanical properties influence masticatory parameters underlying variation in cyclical loading of primate jaws: chewing frequency, chewing investment, and chewing duration. High-speed video recorded dynamic diet-related chewing patterns in isolated and unrestrained primates presented a known mass of five foods that parallel the range of properties for items ingested by wild primates. Intra- and interspecific analyses compared chewing parameters with food stiffness, toughness, and respective oral fragmentation indices.

Contrary to received wisdom, toughness does not always underlie increases in cyclical loading and loading duration. Rather, in some species, elevated chewing investment and duration is linked to the elastic modulus, which suggests that stiff foods can engender higher peak loads and increased cyclical loading. Such variability appears related to the mitigating role of tooth relief on the oral breakdown of food items of specific properties, which in turn affects cyclical loading.

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### Hominin Adaptation and Variation within a Paleocological Context: An Integrative Approach

AMY L. RECTOR<sup>1</sup>, KAYE E. REED<sup>2</sup> and DENISE SU<sup>3</sup>

<sup>1</sup>Anthropology, School of World Studies, Virginia Commonwealth University, <sup>2</sup>Institute of Human Origins and School of Human Evolution and Social

Change, Arizona State University, <sup>3</sup>Paleobotany and Paleocology, Cleveland Museum of Natural History

With the discovery of new fossil species over the last 20 years, it has become clear that east African hominin diversity was greater than previously thought during the Pliocene. Detailed analyses of the ecological and environmental data of each taxon have not always kept pace with new discoveries. Without an integration of each specific taxon and its ecology we are unable to hypothesize about the various niches each one may have occupied, nor about possible regional differences that may have contributed to appearances of different taxa. We ask if there are major differences in ecology among *Australopithecus afarensis* localities at Laetoli, Woranso-Mille, and Hadar – 15 assemblages in total.

Here we compare the paleoecology of different assemblages of *A. afarensis* through the integration of data from multiple lines of evidence, including isotopes, dental microwear, community ecology, taxonomic composition, and taxonomic abundances. Laetoli and Woranso-Mille are deposits of roughly the same time period, but separated by thousands of kilometers, while the Hadar assemblage allows comparison to a later period. We assembled species lists and abundances from the three localities to compare distribution of taxa by tribe and/or family at each locality, species similarity, and community analyses using correspondence analysis (CA) to compare body size, diet, and substrate categories. The communities from Woranso-Mille and Hadar are more similar to each other than either is to Laetoli. Proportions of taxa, however, are different among all three regions. CA results indicate that at different times and places *A. afarensis* existed in divergent habitats.

### Preliminary Study of the Cercopithecidae from Leado Dido'a Locality, Woranso-Mille (central Afar), Ethiopia

HAILAY REDA<sup>1</sup>, STEPHEN R. FROST<sup>1</sup>, EVAN SIMONS<sup>1</sup>, MONYA ANDERSON<sup>1</sup> and YOHANNES HAILE-SELASSIE<sup>2</sup>

<sup>1</sup>Anthropology, University of Oregon, <sup>2</sup>Physical Anthropology, Cleveland Museum of Natural History

Woranso-Mille is a Pliocene paleontological site located in the Afar region of Ethiopia. Here we describe 622 cercopithecoid fossil specimens from one of its localities, Leado Dido'a (LDD), representing at least 6 species (*Theropithecus oswaldi* cf. *darti*, two other papionins, and three colobines). The cercopithecids from LDD are dated to 3.47-3.33 Ma, and thus intermediate in age between the previously described 3.77-3.57 Ma Woranso-Mille cercopithecids and Hadar. *Theropithecus oswaldi* cf. *darti* from all these sites is cranio-dentally similar, but specimens from the older Woranso-Mille deposits are more primitive, especially in the lower molar morphology and

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their mandibular corpus fossae being deeper, compared to Hadar and LDD. The large papionin from LDD is larger than contemporaneous *Theropithecus* and has low crowned molars with thick enamel. The small papionin from LDD is comparable in size with *Pp. cf. jonesi* from Hadar. LDD small papionins share absence of anteorbital drop and mandibular morphology with *Pp. cf. jonesi* from Hadar, but have more developed maxillary fossae and less flaring molar crowns. The largest colobines from LDD are similar in size to *cf. Rhinocolobus turkanaensis* from Hadar, although at least some of them show the presence of a maxillary sinus. There are also some specimens similar in size to *Cercopithecoides meaveae*, and an additional colobine similar in size to extant *Colobus* and Colobinae gen. et sp. indet. from the older Woranso-Mille sites. The taxonomic and paleoecological implications of the LDD cercopithecids are also discussed.

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### **Plio-Pleistocene paleoenvironments of the Shungura Formation based on bovid dental adaptation and abundance analysis**

WELDEYARED H. REDA<sup>1</sup> and ZERESENAY ALEMSEGED<sup>2</sup>

<sup>1</sup>Department of Archaeology and Heritage Management, Aksum University, <sup>2</sup>Organismal Biology and Anatomy, University of Chicago

Abundant fossil remains of mammals, including hominins, have been recovered from the Plio-Pleistocene deposits of the Shungura Formation in the lower Omo Valley of South Ethiopia. Dental adaptation is used here to investigate how bovids responded to changing climatic conditions and environments. Hypsodonty index (HI) comparison between fossil ( $n=302$ ) and modern samples ( $n=53$ ) showed that overall fossil bovids were less hypsodont than their extant representatives, but with an increasing trend through time. Tribe-level HI indicates that Alcelaphini was very hypsodont starting from the late Pliocene while Aepycerotini and Reduncini maintained relative hypsodonty though to a lesser extent. In contrast, Tragelaphini had brachydont to mesodont molars for most part and became considerably hypsodont by 2.32-2.27 Ma but reversed to its ancestral form thereafter. These results show that patterns of dental adaptation and changes through time were not uniform. Yet, combined results of HI and abundance analyses show a progressive shift from a more woodland-adapted tribes in Members A to E (3.6-2.32 Ma), to dwellers of more open and dry environments in Member F (2.32-2.27), and wetland and edaphic grassland dwellers thereafter. Our findings have implications for our understanding of hominin environments in Shungura, particularly that of the *Paranthropus* lineage, which seems to acquire novel dentognathic adaptations for more abrasive diet after 2.3 Ma.

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### **Biogeography, Endemism, and Functional Trait Community Structure: Basinal Differences in the Pliocene**

KAYE E. REED, IRENE E. SMAIL, JOHN ROWAN, JOSHUA ROBINSON, ELLIS M. LOCKE, IGNACIO A. LAZAGABASTER and CHRISTOPHER J. CAMPISANO

Institute of Human Origins and School of Human Evolution and Social Change, Arizona State University

Differences in hominin taxonomic representation across fossil sites can be attributed to geographic as well as habitat differences, as the continuity of vegetation physiognomy diminishes over greater geographic distance. Previous reconstructions of habitats in the Turkana Basin (TB) and lower Awash valley (LAV) suggest both were mosaic, savanna habitats during the Pliocene. We suggest that this broad environmental generalization likely masks more subtle differences between the two regions. We hypothesize that fundamental differences existed between the LAV and TB between ~ 4.0 and ~2.5 Ma that would have influenced community structure, taxonomic composition, and species abundances between these basins.

We generated species lists of all herbivorous mammals for members and/or localities from the two basins. Carbon isotope values and dental morphology were used to assign a diet category to each species. Similarly, we assigned a substrate use category to each species based on morphological studies, or taxonomic uniformitarianism in the case of ungulates. Fossil assemblages were compared using a correspondence analysis (CA) with 202 modern African localities to analyze habitat differences. We also compared the abundances of taxa (e.g., tribes) and analyzed species similarity indices among assemblages. CA results suggest that the TB assemblages were more closed and mesic than assemblages from the LAV. Similarity indices and comparisons of taxonomic abundance also show that there were sizeable basinal differences in species representation and abundance between basins. Our basin-scale comparisons imply that dispersal barriers between these basins may have contributed to the development of endemic faunas within more specific habitats.

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### **Juvenile Skeletal Sexual Dimorphism under Poor Environmental Conditions**

SARAH REEDY

Anthropology, University of Massachusetts, Amherst

Finding statistically significant sexual dimorphism in subadult remains is a challenge since secondary sexual characteristics, like discrete pelvic and cranial traits, don't develop until after

puberty. When dimorphism is found, results are often limited by small samples and vary between populations. Previous research suggests that poor environmental conditions decrease dimorphism in height, since boys are more likely to exhibit stunted growth. This research evaluates patterns of juvenile sexual dimorphism in long bone length, joint, cranial and dental size in three Industrial Era skeletal samples shown to exhibit signs of stress such as stunting, malnutrition, and disease. Discriminant function analysis (DFA) was used to test whether combinations of skeletal measures can be used to sex juvenile remains.

DFA shows that proximal metaphyseal breadths of the tibia, femur, and midshaft tibial, femoral, and humeral breadth measurements, as well as clavicular, mandibular, and various cranial measurements yield 71-94% correct sex identification for children 0-12 years. For 0-3 year olds, tibial, radial, femoral, and humeral proximal and distal metaphyseal breadths, and midshaft tibial, femoral, humeral, and radial breadth identify sex with 79-91%. Results show that upper limb, cranial, and joints regions do exhibit sexual dimorphism in subadults, and that a multivariate approach produces reasonably good sex estimates. The accuracy of sex estimates in children 0-3 years may reflect testosterone surges in gestation and early infancy. Given that skeletons of children often represent those growing under conditions of stress, we must focus on variables that are less impacted by environment when analyzing dimorphism.

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### **Evolution of Gibbons and Siamang: What do we Know?**

ULRICH H. REICHARD<sup>1,2</sup> and MICHELLE M. CROISSIER<sup>2</sup>

<sup>1</sup>Department of Anthropology, Southern Illinois University, <sup>2</sup>Center for Ecology, Southern Illinois University

The evolution of Asia's small apes is subject to considerable debate as the lack of fossils cannot offer support to any of the proposed molecular divergence times, which range from 15 to 26 mya, and coincide roughly to the Oligocene/Miocene turn. However, a common ground among researchers is that the family had split into four genera by the late Miocene (6.7 mya) and that further speciation occurred in the Plio-Pleistocene. We propose that aspects of hylobatid evolution can be inferred by comparing the molecular data to known paleoclimatic and tectonic events. In doing so, it seems unlikely that hylobatids split from stem hominoids before 17 mya, because the *Gomphotherium Landbridge* only connected Africa with Eurasia at ~18-19 mya and

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hylobatids seem to be of Asian origin. Regarding the families' divergence into four genera we argue that stem hylobatid populations had become isolated in the Hengduan Mountains, to which they had retreated in response to cooling temperatures, increasing aridity and stronger monsoon seasonality that resulted in forest fragmentation and the emergence of grasslands following the middle Miocene transition. Later speciation within *Hylobates* and *Nomascus* occurred when Asia experience a brief warm/moist period that led to further population drifts, including isolation on the islands of Borneo, Sumatra, Mentawai, and Hainan. Finally, hylobatid speciation at ~1.7-1.3 mya can be aligned with the formation of Asia's large paleo-rivers. In conclusion, we affirm a strong positive correlation between proposed hylobatid molecular diversification times and changing environmental conditions of the late Miocene and during the Plio-Pleistocene.

### Examining the influence of function and phylogeny on skeletal shape: A case study involving proximal and distal articular surfaces of hominoid third metacarpals

THOMAS R. REIN

Department of Anthropology, Central Connecticut State University

Hominoids vary in their performance of positional behaviors and in overall hand use. This behavioral diversity has been previously linked to differences in the appearance of the third metacarpal, including the relative length of the bone, presence or absence of a styloid process, and the relative width of the dorsal aspect of the distal articular surface. The degree to which phylogeny and selective pressures related to hand use influence the shape of the third metacarpal is not fully understood. The objective of the present study was to tease apart functional and phylogenetic signals present in hominoid third metacarpal shape via a geometric morphometric approach. Fourteen 3D landmark coordinates were collected on the proximal and distal articular surfaces. Principal component analysis of the complete 14 landmark shape configurations separated all genera from one another based on variables such as relative bone length, joint size, and the presence or absence of a styloid process. Furthermore, mean species Procrustes distances derived from these shape configurations clustered genera in a manner reflecting inferred phylogenetic relationships. This was not the case for separate analyses of only the proximal or distal joint configurations. For example, examination of only the distal articular surface provided a clear functional signal related to knuckle-walking not found in the 14 landmark configuration and did not present a phylogenetic signal. The results of this study illustrate the complex interplay between function and phylogeny in the evolution

of third metacarpal shape with implications for interpreting the hominoid fossil record.

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### Paleomobility in the 5<sup>th</sup> century Mediterranean: Oxygen isotope analysis of soldiers from the Battles of Himera (480 BCE, 409 BCE)

KATHERINE L. REINBERGER<sup>1</sup>, BRITNEY KYLE<sup>2</sup>, PIER FRANCESCO FABBR<sup>3</sup>, STEFANO VASSALLO<sup>4</sup> and LAURIE J. REITSEMA<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Georgia,

<sup>2</sup>Department of Anthropology, University of Northern Colorado,

<sup>3</sup>Department of Cultural Heritage,

Università del Salento, <sup>4</sup>Regional Archaeological Superintendence of Palermo, Italy

The formation of shared identities across cultural and geographic borders is an important concept in anthropology, particularly when researching globalization and state-level conflict. This study investigates the geographic origin of soldiers buried in nine mass graves associated with the two Battles of Himera between the Carthaginians and the Greeks (480 BCE, 409 BCE). This paper compares oxygen isotope ratios between two battle contexts, along with contemporaneous non-soldiers, to reveal possible differences in where these soldiers originated. Historical accounts describe a mixed army of individuals from other parts of Sicily and the Mediterranean, suggesting shared motivations and identity regardless of geographic location.

The oxygen isotope ratio of tooth enamel primarily reflects the isotopic composition of drinking water when an individual was a child, and so is a useful indicator of migration patterns. Tooth enamel apatite was sampled for oxygen isotope ratios ( $\delta^{18}O$ ) from human remains ( $n=65$ ). Preliminary results show the individuals from the mass graves had variation in isotopic values suggesting different water sources (mean  $\delta^{18}O=-5.5\% \pm 1.5$ ). This suggests the military force was made up of a more diverse group of people than just the local population. This research supports historical accounts of a mixed army. This study increases our knowledge of army formation and recruitment in the 5<sup>th</sup> century Mediterranean. In addition, the research contributes to our understanding of the Himera assemblages, and allows us to consider how a sense of shared Greek identity could encourage people distributed throughout the ancient Mediterranean to support a foreign Greek cause.

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### Craniometric variation of Early Horizon Native Californians: New perspectives on the Howells Craniometric Dataset

WHITNEY B. REINER<sup>1,2</sup> and LESLEA J. HLUSKO<sup>1,2</sup>

<sup>1</sup>Human Evolution Research Center, University of California Berkeley, <sup>2</sup>Department of Integrative Biology, University of California Berkeley

The W.W. Howells modern human craniometric dataset includes over 2,500 individuals from 28 Holocene populations worldwide. Owing to the wide variation in human cranial morphology, this dataset is currently the best research tool available for analyses of cranial variation in humans. The Howells dataset is used both to test and generate hypotheses in studies of anatomically modern humans and fossil hominids, and is used in forensic investigations. North American Indians are represented by two populations in the Howells dataset. Here, we provide cranial measurements for two Native Californian populations (San Joaquin and Alameda counties) from the Early Horizon (ca. 5000 years BP) to reassess the range of cranial variation for modern humans characterized by the Howells dataset. We used three dimensional digitization and Threeskull to collect craniometric measurements from 60 adult crania following Howells definitions, and performed univariate analyses to assess variation. All data were collected from remains that are culturally unidentifiable under NAGPRA. Bringing these Native Californian populations into the Howells worldwide assessment of human cranial variation expands the range of human cranial variation for 20 measurements, 15 of which extend the higher end of the range, while 5 of the measurements extend the range at the lower end. We also present multivariate and sex-specific analyses of these new data, adding to the understanding of this larger range of cranial variation within modern humans.

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### A case of thoracic insufficiency syndrome in Cabeçuda Shellmound, Brasil

SILVIA REIS<sup>1</sup>, ALEJANDRA SALADINO<sup>2</sup>, MURILLO BASTOS<sup>1</sup> and CLAUDIA RODRIGUES-CARVALHO<sup>1</sup>

<sup>1</sup>Departamento de Antropologia, Universidade Federal do Rio de Janeiro, <sup>2</sup>Departamento de Estudos e Processos Museológicos, Universidade Federal do Estado do Rio de Janeiro

Cabeçuda shellmound was first scientifically excavated in 1950, by Castro Faria. As a monumental shellmound in Santa Catarina State (South of Brazil), originally with over 20 meters of height and 400 square meters of area, it stands as an important site of long occupation, with dates ranging from approximated 1052 BP to 4766 BP. Cabeçuda shellmound was revisited in 2010, 2011 and 2012, with excavations conducted mainly in locus 1 and 2. From locus 1, a child (estimated around 8 years old) was found adorned

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with a necklace made of shells and two shark teeth, a belt also made of shells and pigmented with ochre. Presence of fused ribs, in proximal and/or distal portions, hemivertebrae and other anatomic congenital modifications points to a diagnose of thoracic insufficiency syndrome, with only the left side compromised. As an individual with treponematoses was also found in locus 1, and at least two more with inespecific periosteal lesions, a future excavation will work with a hypothesis of this locus as a special sector in Cabeçuda or a distinct period of health stress.

### Elemental Ratios of Carbon and Nitrogen Track Weaning in a Graminivorous Primate (*Theropithecus gelada*)

LAURIE J. REITSEMA<sup>1</sup>, NOAH SNYDER-MACKLER<sup>2</sup>, JACINTA C. BEEHNER<sup>3,4</sup>, THORE J. BERGMAN<sup>4</sup> and AMY LU<sup>5</sup>

<sup>1</sup>Department of Anthropology, University of Georgia, <sup>2</sup>Department of Evolutionary Anthropology, Duke University, <sup>3</sup>Department of Anthropology, University of Michigan, <sup>4</sup>Department of Psychology, University of Michigan, <sup>5</sup>Department of Anthropology, Stony Brook University

We report and interpret carbon and nitrogen stable isotope and elemental evidence for diet and weaning among wild gelada monkeys (*Theropithecus gelada*). Feces increasingly are utilized as substrates for isotopic analysis among non-human primates. This paper takes stock of what is known about fecal stable isotope data among primate taxa, and what remains incompletely understood.

We measured stable carbon and nitrogen isotope ratios ( $\delta^{13}\text{C}$ ;  $\delta^{15}\text{N}$ ) of 150 fecal samples representing 46 dyads collected in the Simien Mountains National Park in Ethiopia, hypothesizing that isotopic ratios are significantly different between infants and their mothers, reflecting anticipated isotopic trophic effects, and that these differences decrease as a function of infant age, reflecting weaning.

Mother-infant differences in  $\delta^{15}\text{N}$  ratios do not decrease straightforwardly with infant age ( $r^2=0.05$ ).  $\delta^{13}\text{C}$  values of infants increase with age ( $r^2=0.18$ ), reflecting solid food consumption. Elemental data (carbon and nitrogen content of feces) give the closest approximation of weaning status, with carbon-to-nitrogen ratios increasing with infant age ( $r^2=0.60$ ). Isotope data are highly varied overall. Variation across weeks and months likely tracks seasonal changes in diet composition and plant isotopic ratios. To explain high within-group  $\delta^{15}\text{N}$  variability on individual sampling days, we integrate recently generated gelada microbiome data to explore how gut microbiota fractionate  $\delta^{15}\text{N}$  as nitrogen is passed through the gastrointestinal tract.

We propose that expectations for trophic effects in fecal stable isotope and elemental data should

be species-specific moving forward, and that isotopic and elemental data are best used in tandem in applications to primate ecology.

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### Association between Maternal Stress and Telomere Length in the Eastern Democratic Republic of the Congo

PETER H. REJ<sup>1,2</sup>, NICOLE C. RODNEY<sup>1,2</sup>, DARLENE A. KERTES<sup>2,3</sup> and CONNIE J. MULLIGAN<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Genetics Institute, University of Florida, <sup>3</sup>Psychology, University of Florida

Telomeres stabilize the terminal ends of linear chromosomes, and shorten throughout the lifespan, leading to an eventual decrease in cellular function. Accordingly, shortened telomeres have been implicated as a possible mechanism for the onset of age related diseases. Furthermore, telomere shortening is associated with exposure to psychosocial stress, with early traumatic experiences having a greater impact on telomere length (TL) than those occurring later in life. The object of the present study is to determine how maternal stress influences TL in mother-neonate dyads in the eastern Democratic Republic of the Congo, a region that has experienced intense conflict and violence directed towards women for the past two decades.

Relative TL was measured via qPCR in 101 Congolese mother-neonate dyads. DNA was isolated from venous blood collected from mom and baby, umbilical cord blood, and placental tissue. TL was assayed for all tissue types. Stress measures were collected via ethnographic interviews and culturally adapted surveys. Maternal stress data were coded, and two distinct summary variables reflecting chronic stress and war-related traumas were calculated.

Multiple regression analyses were performed to test for associations between maternal stressors and TL, independently for each tissue. Significant association between TL and maternal exposure to war-related stressors was observed in placental samples ( $p=0.02$ ). No other significant associations were detected. The placenta's role as a protective barrier to the developing fetus from maternal stress hormones has been well studied. Our findings suggest that TL is reflective of, and may play a role in this function of the placenta.

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### Taphonomy in cementochronology

WILLIAM RENDU<sup>1,2,3</sup>, AARON J. STUTZ<sup>4</sup>, LIONEL GOURICHON<sup>5</sup>, STEPHAN NAJ<sup>2,3</sup>, MANON

VUILLIEN<sup>5</sup>, CARLOS SÁNCHEZ-HERNÁNDEZ<sup>6</sup> and ERIC PUBERT<sup>1</sup>

<sup>1</sup>PACEA, CNRS - Université Bordeaux, MCC, <sup>2</sup>Department of Anthropology, NYU, <sup>3</sup>CIRHUS, CNRS - NYU, <sup>4</sup>Oxford College, Emory University, <sup>5</sup>CEPAM, Université Côte d'Azur, CNRS, <sup>6</sup>Campus Sescelades, IPHES

Cementum increment analyses have been largely applied to various archaeological contexts and topics for addressing the question of age and/or season at death of individuals, from a large range of mammal species. However, few analyses have directly tackled the question of cementum taphonomic alterations.

Various post-depositional processes such as physical weathering, microbial digestion, chemical alteration, collagen leaching and apatite recrystallization can affect and damage the cementum of archaeological teeth, even when the roots are still embedded in the alveolar bone.

These modifications can hardly be detected by the macroscopic examination of the root surface and are thus prejudicial sources of distortions and errors when analyzing cementum increments for seasonality and mortality studies.

In this study, we revised several archaeological series of different taxa (human, bison, deer, sheep) from various contexts (funeral, camp sites) and time periods (Middle Paleolithic, Neolithic, Medieval), in order to evaluate the frequency and the impact of post-mortem modifications and to propose guidelines and recommendations to tackle them.

Results evidenced a wide variation in taphonomic changes from 20% to 90% of samples affected in some collections. Nevertheless, the implementation of our protocol provides solutions to get around this issue, even in extreme cases.

Understanding taphonomic changes also helped to explain why some affected samples were rejected, artificially increasing the analysis rate of success in some publications, and how this could be avoided in the future through the implementation of our revised age and seasonal spectrum for each studied sites.

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### A Preliminary Analysis on the Cranial Variation within Prehistoric Mexico

SAMUEL R. RENNIE<sup>1</sup>, MARGARET CLEGG<sup>2</sup>, SILVIA GONZALEZ<sup>1</sup> and JOSÉ C.J. LÓPEZ<sup>3</sup>

<sup>1</sup>Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, <sup>2</sup>The Department of Genetics, Evolution and Environment, University College London, <sup>3</sup>Instituto Nacional de Antropología e Historia, Museo Nacional de Antropología

Paleomigration into the Americas' has mainly focused on using craniometric data from

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specimens from the USA or South America with very little focus on Central American countries. Also, research has normally concentrated on specimens from the late Pleistocene – early Holocene periods. This preliminary study revolves around a comparison of Central Mexican individuals dating between 10-12kya and a collection of human crania from the Coahuila region of NE Mexico dating between 1-2kya.

Craniometric data were sourced from peer-reviewed published articles and books. From this, 81 crania from the Candelaria Cave, Coahuila and five crania from Central Mexico were analyzed. To utilize the full data set (n=86), missing data were replaced by running a *k* Nearest-Neighbor (*kNN*) analysis which made it possible to compute a PCA.

The results from the PCA show that males and females cluster separately along PC1 and a clear divide between the two different samples can be seen along PC2. From the component matrix, we see that it is a mix of both the splanchnocranium and neurocranium that drive the variation between the sexes *and* between the two samples. Previously the skulls from La Candelaria Cave were considered to be very similar to the ones in Central Mexico, but this is not the case, adding information in terms of potential migration routes.

Further work is needed to help fully explore the cranial variation seen within prehistoric Mexico. Re-analysis of the Coahuila skulls will be undertaken to validate the original measurements that were published in the early 2000's.

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### A Study of Structural Variants in Ancient Genomes and their Introgression into Modern Humans

SKYLER RESENDEZ, DUO XU, JUSTIN BRADLEY and OMER GOKCUMEN  
Biology, University at Buffalo

Structural variants, which are variations of the copy number, location or orientation of segments of DNA rather than single nucleotide differences, have recently been shown to play major roles in recent human evolution. However, to our knowledge, no previous study directly evaluated the landscape of structural variants in ancient genomes. Here, we used available bioinformatics tools to discover structural variants in the genomes of the Altai Neanderthal, Denisovan, and a 45 thousand year old anatomically modern human. Our data provide a snapshot of hominin genomic variation in ancient Central Asia (Siberia) between 40-55 thousand years ago. For comparative purposes, we also sequenced a modern European genome at similar read-depth to the ancient genomes (~30X) and conducted the same structural variation discovery analysis. Overall, we found that each ancient genome had between 5,032-8,757 duplications and 3,212-3,900 deletions. In contrast, we found 1,508 duplications

and 8,435 deletions in the modern European genome. Furthermore, we documented significant differences in the average size and exonic content among ancient genomes. We conducted several downstream analyses to investigate the technical, demographic and adaptive reasons underlying the disparity between structural variation distribution in ancient and modern genomes, as well as between different hominin species. In addition, we resolved the haplotype structure of a complete gene deletion (*SPATA45*), which likely introgressed from Neanderthals into the modern human lineage.

Omer Gokcumen's start-up funds from University at Buffalo Research Foundation

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### Optimizing Long-Run Energy Harvesting Strategies in Central Asian Nomadic Pastoralists

ADAM Z. REYNOLDS and PAUL L. HOOPER  
Anthropology, Emory University

Optimality models derived from behavioral ecology have been applied with remarkable success toward understanding the behavior of human foragers, including diet breadth, work effort, mobility, and technological investment. Despite the historical importance and modern-day resilience of pastoralism – economic production based on domestic animal herds – few models rooted in evolutionary theory have been developed to understand the constraints and decision problems inherent to pastoralist subsistence strategies. In this talk, we present a new behavioral ecological model and recent quantitative field data to address this lacuna. This evolutionary optimization model characterizes optimal strategies for maximizing long-run benefits of herds by balancing tradeoffs affecting rates of animal breeding, slaughter, and market sales at the level of residential groups. We then test predictions from the model using data collected through ethnographic fieldwork with nomadic pastoralists in Mongolia and southern Siberia. We emphasize the role of economic and life history tradeoffs to explain variation in energy harvesting strategies between residential groups.

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### Single nucleotide polymorphisms in the FGFR3 gene: interpreting cranial, neural, and vascular changes in prehistoric cases of achondroplasia

SIERRA M. H. LEE<sup>1</sup>, NICOLE K. APODACA<sup>2</sup>, REBECCA S. JABBOUR<sup>3</sup> and GARY D. RICHARDS<sup>4</sup>

<sup>1</sup>Molecular and Cell Biology, University of California, Berkeley, <sup>2</sup>Integrative Biology, University of California, Berkeley, <sup>3</sup>Biology, Saint Mary's College of California, <sup>4</sup>Biomedical Sciences, AA Dugoni School of Dentistry, University of the Pacific

Achondroplasia is the most common form of dwarfing and shortness of limbs (1/28,000 – 1/48,000 live births USA). The condition is

caused by one or two SNPs in the *FGFR3* gene. Although partial skeletons complicate diagnoses in prehistoric contexts, achondroplasia is the best-represented chondrodystrophy globally (n=10, plus n=3 possible). In North America six prehistoric achondroplastics are known (50 BCE to 1800 CE). Based on virtual skull and endocranial reconstructions, we delineate cranial and neural morphologies in prehistoric achondroplastics that result from *FGFR3* mutations and discuss how these cranioneural changes impacted the lifeways of affected individuals.

Two achondroplastic skulls were examined, one from the Augustine Site (CA-Sac-127: Late Horizon 1500-1800 CE) and one from an unprovenienced prehistoric context. These individuals were compared to normal skulls from prehistoric California (n=15). CT scans were made on a GE LightScribe VCT scanner (0.3-mm isotropic voxels). Following segmentation, isosurfaces of the skull and surface maps of the endocranial cavity were created in Amira (v. 6.1).

Reference to literature descriptions confirmed a diagnosis of achondroplasia in both cases. Endocranial reconstruction revealed significant vascular changes. These included enlarged internal carotid (endocranial) and middle meningeal arteries and expanded dural sinuses, extensive shunting to emissary sinuses, and narrowed jugular foramina. *FGFR3*-related increases in neural tissue (>neurons, decreased cellular apoptosis) appear to result in brain asymmetries (expanded right pre/postcentral gyri, cupped parietal lobes, midsagittal swelling). Cranial reconstruction also revealed unexpected variation in chondrocranial components. These observations provide new insights into the cascade of impacts resulting from *FGFR3*-induced cranioneural changes.

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### Life on the "Ultimate Island": The Adaptive Radiation of the Sulawesi Macaques and their Shared Ecologies with Humans

ERIN P. RILEY  
Anthropology, San Diego State University

The oceanic island of Sulawesi, Indonesia has long been of interest to scholars; the most notable being Alfred Russell Wallace. During his explorations of the Malay archipelago, Wallace was particularly struck with the ecology of Sulawesi, noticing its depauperate yet distinctive mix of Asian and Australasian fauna. Sulawesi is now known as occupying the center of Wallacea; a unique biogeographical zone where endemism levels are incredibly high. These features, along with its long history of separation, explain why Sulawesi is regarded as "the ultimate island." Among those endemic include seven of the 23 species of the genus *Macaca* (Fooden 1969); which represents 30% of the genus in only 2% of its geographical range. In line with island theory,

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the ecological setting of the Sulawesi macaques is considered distinct: a lack of predators and reduced interspecific competition. However, this characterization neglects the human primates who have been important components of Sulawesi's ecology since before the last glacial maximum. Moreover, recent research has demonstrated that human habitat alteration has resulted in areas where humans and macaques are sympatric, and therefore, experience competition for resources. In this presentation, I will review the origin and adaptive radiation of the Sulawesi macaques, and explore how the past and present human-macaque interface (e.g., overlapping resource use, predation, pet keeping, and introductions) may (have produced) be producing different sets of selective pressures and (have shaped) are shaping biogeographical patterns, with important implications for our understanding of how species adapt to changing environments in the Anthropocene, and beyond.

### 3D reconstructions of cortical canal network is an efficient method to differentiate human from animal fragmentary bones

CHARLOTTE RITTEMARD<sup>1,2</sup>, OLIVIER DUTOIR<sup>1,2,3</sup> and HELENE COQUEUGNIOT<sup>1,2,4</sup>

<sup>1</sup>Laboratoire d'Anthropologie biologique Paul Broca, Ecole Pratique des Hautes Etudes - PSL University, <sup>2</sup>UMR 5199 PACEA, CNRS - University of Bordeaux, <sup>3</sup>Department of Anthropology, University of Western Ontario, <sup>4</sup>Department of Human Evolution, Max Planck Institute

Human and animal bone differentiation is one of the major steps in the study of skeletal remains which is crucial for the interpretation of skeletal assemblages in archeological sites and for the expertise of forensic cases.

Bone fragmentation can limit or impede the taxonomic identification only based on macro-morphological observation. Study of bone microstructure provides then new clues in such fragmented/weathered cases. Cortical bone canal network (CBCN) is particularly informative as it is supposed to present a distinctive pattern between species.

In order to identify specific patterns of CBCN, we compared femoral and humeral diaphyses of human, cow, pig, and sheep. For each species, we selected 3 Volumes of Interest located along the bone shaft that we scanned using 2 X-ray methods ( $\mu$ CT and Synchrotron-CT, resolution: 2-5 $\mu$ m) and reconstructed in 3D using dedicated software programs.

Moreover, this approach presents the advantages to be non-destructive and to provide both qualitative and quantitative data representative of the canal network variability.

Our results showed that the human pattern of CBCN is clearly distinct from animal ones,

particularly for the number of connections between canals. The CBCN pattern appeared at first glance to be less discriminant between animal species, nevertheless it allows to identify successfully each of the studied animal taxa.

The 3D reconstructions of CBCN appear to be an efficient method to distinguish human from animal bones. It opens up new perspectives in anthropology, archeozoology, forensic and archaeological sciences.

### A three-dimensional geometric morphometric evaluation of shape variation in the hybrid baboon cranium

TERRENCE B. RITZMAN<sup>1,4,5,6</sup>, DAVID C. KATZ<sup>2</sup>, KATHERINE E. WILMORE<sup>3</sup>, JAMES CHEVERUD<sup>7</sup>, JEFFERY ROGERS<sup>8</sup> and REBECCA R. ACKERMANN<sup>4,5</sup>

<sup>1</sup>Department of Neuroscience, Washington University School of Medicine, <sup>2</sup>Department of Anthropology, University of California, Davis, <sup>3</sup>Department of Anatomy and Cell Biology, University of Western Ontario, <sup>4</sup>Department of Archaeology, University of Cape Town, <sup>5</sup>Human Evolution Research Institute, University of Cape Town, <sup>6</sup>School of Human Evolution and Social Change, Arizona State University, <sup>7</sup>Department of Biology, Loyola University - Chicago, <sup>8</sup>School of Medicine, Baylor University

Baboons are arguably the best-studied primate model for understanding the effects of hybridization. Previous studies have indicated that hybrid baboon crania possess non-metric traits that are rare in parent populations. Although previous research indicates that cranial size and shape in hybrid baboons is highly variable, this issue has not been extensively studied. Here we quantify cranial size and shape variation in hybrid baboons. Twenty-seven three-dimensional landmarks were collected from samples of *Papio cynocephalus* ( $n=80$ ), *P. anubis* ( $n=79$ ), and their F1 hybrids ( $n=75$ ). Landmark data were registered using Generalized Procrustes Analysis and principal components analysis was performed. An analysis of allometric patterns was also employed. The results demonstrate significant differences in cranial shape among all three groups ( $p<0.001$ ), but hybrids more closely resemble *P. anubis*. Variation in the sample primarily involves the shape of the mid- and upper portions of the facial skeleton. Allometric analyses reveal that the *P. cynocephalus* trajectory is significantly different from that of *P. anubis* ( $p<0.0001$ ) and the hybrids ( $p<0.001$ ); however, the allometric trajectories of *P. anubis* and the hybrids are not significantly different ( $p=0.52$ ). The results of this study suggest that the shape of the hybrid baboon crania is generally intermediate between parents, but that, in both shape and allometric trajectory, the hybrids are more similar to the larger-bodied *P. anubis*. These results provide an important new framework for understanding the cranial phenotype in hybrid primates and permit

the development of hypotheses regarding potential hybrids in the human fossil record.

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### Growth and reproduction in adult women: understanding the interactions of evolution and culture in American and rural Brazilian populations

ANNA C. RIVARA<sup>1</sup> and SABRINA G. PAIVA<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of South Florida, <sup>2</sup>Departamento de Genética e Morfologia, Universidade de Brasília

Life history theory posits that energy is allocated towards: growth, maintenance, and reproduction (Stearns, 1992; McDade, 2005). When energy is monopolized by one, trade-offs must occur in the remaining processes. This study tested whether trade-offs occurred between the growth, fertility, or Immunoglobulin E (IgE) production, of two different populations of adult women. Analyses were conducted on women 18 years and older from the National Health and Nutritional Examination Survey 2005-2006 (NHANES), a representational survey of the American population ( $n=1707$ ). Additionally, women 30 years and older from the Kalunga quilombo (historical Black rural community) in Goiás, Brazil were analyzed ( $n=171$ ); ANOVA tests were conducted using SAS 9.4. Height was found to significantly vary between the numbers of pregnancies in American women ( $p=0.0002$ ), and approached statistical significance in the Brazilian population ( $p=0.056$ ). In both populations, taller women were found to have had fewer pregnancies. Additionally, IgE levels were significantly different between women divided by numbers of pregnancies in the USA ( $p=0.0003$ ) but not in Brazil ( $p=0.604$ ). Height was also significantly different between the ages when women experienced menarche in the American population ( $p=0.006$ ), but not the Brazilian population ( $p=0.213$ ). In both populations, shorter women experienced earlier ages at menarche. These findings suggest possible life history trade-offs are occurring between growth and reproduction. However, the differences found between the Americans and the Kalunga also indicate that socio-economic and ecological disparities may have a strong influence on the expression of life history traits in these two populations.

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### Group membership, individual identity, and sex encoded in *Saguinus imperator* long calls

EFSTATHIA E. ROBAKIS<sup>1,2</sup>, MRINALINI WATSA<sup>1,2</sup> and GIDEON ERKENSWICK<sup>3</sup>

<sup>1</sup>Anthropology, Washington University in St. Louis,

<sup>2</sup>Field Projects International, <sup>3</sup>Biology, University of Missouri–St. Louis

Long-distance vocalizations are an essential form of communication for arboreal primates that inhabit dense forest where visibility is low. The ability to encode information about the producer of a given long call would be particularly advantageous in areas of territory overlap, where primates hear vocalizations of individuals belonging to their own group and neighboring groups. Emperor tamarins (*Saguinus imperator*) at the Estación Biológica Los Amigos in the Madre de Dios Department, Peru, occur at 1.5 groups per km<sup>2</sup>, and frequently encounter extra-group members in areas of home range overlap. We tested whether emperor tamarin long calls encode group membership, individual identity, and sex using vocalizations from 11 adults belonging to four groups. Discriminant function analysis using eight spectral and temporal parameters confirmed that enough variation was present in this sample to differentiate all three variables. The ability to distinguish these characteristics may facilitate group cohesion in dense forest, and may be particularly helpful when neighboring groups are ranging near each other. Future research will include vocalizations from juveniles and additional groups to elucidate the degree to which intergroup differences in vocal production are learned in wild emperor tamarins.

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### Plagiocephaly and the maternal-fetal interface at Harappa

GWEN ROBBINS SCHUG

Anthropology, Appalachian State University

In biology, the maternal-fetal interface refers specifically to the hemochorial, immunological, and hormonal relations between mother and offspring in placental mammals. Anthropologists broaden the definition to include sociocultural and behavioral aspects of the developmental environment, maternal-fetal relations, and identity construction. This poster describes the differential diagnosis and a social bioarchaeology of two immature crania from an ossuary (Area G) located southeast of the prehistoric city of Harappa. Both children died at approximately 5 years of age and both were affected by plagiocephaly—one synostotic and the other non-synostotic—a condition whereby the cranium is asymmetrically distorted by unilateral flattening of the frontal or occipital region. In contemporary

clinical practice, this condition is relatively rare (>1 per 100,000 live births) and the specific risks for plagiocephaly include pre- and post-term factors such as intrauterine constraint in cases of plural birth; oligohydramnios; prolonged cranial molding *in utero*; cranial suture agenesis or stenosis; post-natal sleeping posture, supine positioning, and/or conditions that limit movement in young infants and children. Using an osteobiographical approach, deeply contextualized within the archaeological and social context of the Indus Age, the etiology, semiotics, and the experience of the condition is explored.

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### A Bio-Ethnography of Environmental Health and Body Mass in Mexico City: Challenges and Preliminary Results

ELIZABETH F.S. ROBERTS<sup>1</sup> and MARTHA TÉLLEZ-ROJO<sup>2</sup>

<sup>1</sup>Anthropology, University of Michigan, <sup>2</sup>Centro de Investigación en Nutrición y Salud, Instituto Nacional de Salud Publica, Mexico

In 1993, a team of Mexico and U.S. based environmental health researchers partnered to form ELEMENT (Early Life Exposure in Mexico to Environmental Toxicants). The project aimed to study the effects of chemical exposures on childhood growth and development. Since then, ELEMENT project staff have collected biological samples for ongoing epidemiological and molecular analysis from nearly 1700 participants in three birth cohorts, mostly working-class mother and child pairs recruited through Seguro Social clinics in Mexico City. In 2013, a medical anthropologist began collaborating with the ELEMENT research team initiating an intensive ethnographic investigation of ELEMENT participant families, through an examination of their daily lives in their distinct urban neighborhoods. One methodological aim of this collaboration was to use the ethnographic investigation to generate new insights and hypothesis for ongoing research with the birth cohorts. Another aim was to combine data derived from two distinct methodologies (ethnography and biological sample collection) to create a bio-ethnographic account of the effects of chemical exposure in Mexico City. This talk has two parts, 1) we describe the challenges we have faced in trying to bring ethnography and biological sampling together across disciplinary silos, and distinct funding ecologies, and 2) we describe our initial efforts to create bio-ethnographic data focusing on the relationship of increasing body mass in Mexico to various factors across scales (epigenetics, family dynamics, neighborhood environments, and local and national food and chemical landscapes).

### Are metacarpals handy indicators of sex? The applicability of metacarpal metrics in sex determination

KASHIQUE A.S. ROBINSON<sup>1</sup>, TRACY K. BETSINGER<sup>1</sup>, JAIME M. ULLINGER<sup>2</sup> and DANIELLA R. TARQUINIO<sup>2</sup>

<sup>1</sup>Anthropology, State University of New York at Oneonta, <sup>2</sup>Sociology, Criminal Justice, and Anthropology, Bioanthropology Research Institute, Quinnipiac University

When working with human skeletal remains, it is important to accurately determine the sex of individuals. While the bones of the pelvis and skull are the most reliable, they are not always recovered or well preserved. Recent studies have shown metacarpals are a useful alternative. The purpose of this study is to assess metacarpal metric methods on a sample of known sex and age. We test the hypothesis that regression equations developed from other skeletal samples may not predict sex correctly. A sample of 804 metacarpals from 169 individuals who were buried during the 19th century in St. Bride's Church, London were utilized. A maximum of six measurements were taken from each metacarpal using digital sliding calipers and a mini osteometric board. Regression equations from two previous studies (Case and Ross, Khanpetch et al.) were assessed. The Case-Ross equation could be applied to 26 burials; results provided a maximum accuracy rate of 83% for males and 74% for females. Similarly, the Case-Ross study found 80% overall accuracy. Sex for 67 burials could be predicted using an equation from Khanpetch, resulting in a maximum accuracy rate of 48% for males and 0% for females. However, the original study had a maximum accuracy rate of 89.8%. Both studies suggest greater accuracy in predicting sex for males than females using the metacarpals, and indicate that regression equations may not be equally applicable to all samples. When possible, an equation developed from the most comparable sample should be employed.

### Mechanotransduction in bone: lessons from mice

ALEXANDER ROBLING

Anatomy & Cell Biology, Indiana University

Mechanical loading is essential to maintain normal bone metabolism and the balance between bone formation and resorption. The mechanisms that control bone cell mechanotransduction are not fully understood, but several key pathways have been identified. One such mechanism involves Wnt signaling—a pathway involved in many physiologic processes including body axis specification/patterning, and morphogenic signaling. The first clues of Wnt's role in bone biology began with several genetic studies that sought to identify the cause of Osteoporosis Pseudoglioma (OPPG), an autosomal recessive disease characterized by early-onset osteoporosis and

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blindness. Mutant mouse studies revealed that loss-of-function mutation in the WNT co-receptor LDL-Receptor-related Protein 5 (Lrp5) caused OPPG, but perhaps more importantly, that Wnt signaling through Lrp5 is crucial for load-induced bone formation. Moreover, mechanical loading strongly regulates Sost/sclerostin expression—a potent inhibitor of Wnt/Lrp5 signaling. Sost, and its protein product sclerostin, are nearly exclusive to the osteocytes—the cell postulated to be the tissue's sensor apparatus in transducing mechanical loading events. The suppression of sclerostin expression by mechanical loading may provide a mechanism by which Wnt signaling is enhanced and bone formation is enacted. Furthermore, Wnt signaling modulation via Sost/sclerostin also appears to modulate the process of disuse osteoporosis. As the mechanisms of mechanical signal transduction become revealed, a greater range of targetable molecules will be manifest, that might ultimately be exploited to improve bone health among patients with a wide range of skeletal disease.

### Sexual dimorphism in dental cementum microstructure: potential for sexing hominin remains

KATE ROBSON BROWN<sup>1</sup>, ELIS NEWHAM<sup>2</sup>, PRISCILLA BAYLE<sup>3</sup>, IAN CORFE<sup>4</sup> and PAM GILL<sup>1,5</sup>

<sup>1</sup>Department of Archaeology and Anthropology, University of Bristol, <sup>2</sup>Faculty of Engineering and the Environment, University of Southampton, <sup>3</sup>PACEA UMR 5199, University of Bordeaux, <sup>4</sup>Institute of Biotechnology, University of Helsinki, <sup>5</sup>School of Earth Sciences, University of Bristol

Cementum, the connective tissue that anchors mammalian teeth within the alveolar socket, grows continuously and with an annual rhythm; it is recorded by a series of circum-annual increments of contrasting opacity when viewed under light microscopy, with hyper-mineralized increments recording a reduction of growth rates. The aim of this project is to use high-resolution synchrotron-based radiation tomography (SRCT) to test whether the microstructure of cementum is sexually dimorphic in primates. A sample of macaque molars was taken from the cadavers of animals raised under controlled conditions and with known life histories. These individuals were raised for an unrelated project and were culled independently. The molar roots were scanned at the Swiss Light Source on the TOMCAT beamline using 40x and 20x objectives at 0.35 and 0.71 $\mu$ m voxel dimensions (respectively), at 20keV. Reconstructions employed conventional X-ray absorption based ("grid rec") algorithms, and exploratory phase-contrast enhancement ("Paganin-style") algorithms. Reconstructed scans were analysed using commercial software (Avizo, Fiji). Quantitative morphometric techniques were applied to assess variation in microstructure between increments (tortuosity,

3D texture, cellular voids) formed in breeding females, non-breeding females, and males. Principal Component Analysis of these 3D microstructural data demonstrates that male cementum increments are relatively homogeneous and have low microstructural variance, while female increments are significantly more tortuous and varied. These characteristics may reflect hormonal cycling and the impact of pregnancy. This methodology therefore has potential as a tool for sexing fragmented remains in forensic, anthropological and archaeological contexts, as well as sexing in fossil species.

### Life History Transitions: Parents Still Matter more than Female Friends for Adolescent Girls' Mental Health

MICHELLE A. RODRIGUES<sup>1</sup>, SUMMER R. SANFORD<sup>1</sup>, MARY P. ROGERS<sup>1</sup>, KATHARINE M.N. LEE<sup>1</sup>, SARA J. GAY<sup>1</sup>, RACHEL A. MITCHELL<sup>1</sup>, ZARIN SULTANA<sup>1</sup>, JENNIFER AMOS<sup>2</sup>, CARLA D. HUNTER<sup>3</sup> and KATHRYN B.H. CLANCY<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Illinois, Urbana-Champaign, <sup>2</sup>Department of Bioengineering, University of Illinois, Urbana-Champaign, <sup>3</sup>Department of Psychology, University of Illinois, Urbana-Champaign

Adolescence is a life history stage characterized by social transition from juvenile to adult social roles. For girls, this includes shifting from reliance on parents to peers for social support. Social connection, particularly female friendship, affects women's physical and mental health, and we hypothesize this effect should be present during adolescence. Here, we examine how female friendship and parental relationships affect mental health in adolescent girls. We predicted that girls with "very close" female friends and higher quality parental relationships will experience fewer depression symptoms. Data was collected from an ethnically diverse sample of adolescent girls (ages 13-17, N=83) participating in a girls' science camp. Subjects provided a list of their social networks, completed a Parent-Adolescent Communication Scale (PACS) and the Center for Epidemiology Studies Depression Scale (CES-D). Female friendship and PACS were significantly correlated ( $r=0.298$ ,  $p=0.018$ ,  $N=83$ ), and each were negatively correlated with CES-D (friendship:  $r=-0.258$ ,  $p=0.006$ , PACS:  $r=-0.478$ ,  $p<0.001$ ). When combined in a hierarchical linear regression, mean PACS score is the only significant predictor of CES-D ( $R^2=0.219$ ,  $F_{1,81}=23.964$ ,  $p<0.001$ ,  $b=-0.478$ ,  $t=-0.4895$ ,  $p<0.001$ ). Adding friendship category slightly improves the model fit ( $R^2=0.224$ ,  $F_{1,80}=12.836$ ,  $p<0.001$ ); however only PACS is a significant predictor ( $b=-0.440$ ,  $t=-4.319$ ,  $p<0.001$ ). These findings suggest that adolescent girls have not yet transitioned to reliance on the social networks that are important in adulthood. Parental relationships are important for adolescent mental health, and may influence development of close friendships. Further

research will examine if cortisol is a mediating factor between relationships and depressive symptoms.

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### Simultaneous Estimates of Archaic Admixture and Ancient Population Sizes

ALAN R. ROGERS<sup>1</sup> and RYAN J. BOHLENDER<sup>2</sup>

<sup>1</sup>Anthropology, University of Utah, <sup>2</sup>Epidemiology, MD Anderson Cancer Center

To estimate archaic admixture, one must control for the sizes and separation times of ancient populations. We describe a new method that provides simultaneous estimates of these parameters in complex models of population history. Preliminary results indicate that (1) throughout Eurasia, the level of Neanderthal admixture is uniform (about 2%) and Denisovan admixture is near zero; (2) contrary to published results, there is no evidence of excess Neanderthal DNA in East Asia; (3) the situation is different in Melanesia, which exhibits higher levels of admixture from both archaic populations, (4) the population ancestral to modern humans numbered about 18,000 as did that ancestral to moderns and archaics; and (5) the population ancestral to Neanderthals and Denisovans may have numbered only a few dozen individuals.

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### Oxytocin (OT) and Arginine-Vasopressin (AVP) Cell Bodies and Fibers in the Social Behavioral Neural Network in Rhesus Macaques, Chimpanzees, and Humans

CHRISTINA ROGERS<sup>1,3,5</sup>, AMY P. ROSS<sup>5,6</sup>, JEROMY DOOYEMA<sup>4,5</sup>, MARY ANN CREE<sup>4,5</sup>, SHWETA P. SAHU<sup>5</sup>, ETHAN SIEGEL<sup>5</sup>, ED G. STOPA<sup>7</sup>, JAMES K. RILLING<sup>1,2,3,5</sup>, H. E. ALBERS<sup>5,6</sup>, LARRY J. YOUNG<sup>2,3,5</sup> and TODD M. PREUSS<sup>3,4,5,8</sup>

<sup>1</sup>Anthropology, Emory University, <sup>2</sup>Psychiatry and Behavioral Sciences, Emory University, <sup>3</sup>Center for Translational Social Neuroscience, Emory University, <sup>4</sup>Division of Neuropharmacology and Neurodegenerative Diseases, Yerkes National Primate Research Center, <sup>5</sup>Center for Behavioral Neuroscience, Yerkes National Primate Research Center, <sup>6</sup>Neuroscience Institute, Georgia State University, <sup>7</sup>Pathology (Neuropathology) and Neurosurgery, The Warren Alpert Med. School, Brown University, <sup>8</sup>Pathology and Laboratory Medicine, Emory University School of Medicine

The neuropeptides OT and AVP are strongly implicated in the regulation of social behavior in mammalian species. While OT- and AVP-producing cells are consistently located in the hypothalamus across species, less is known about variation in the distribution of extra-hypothalamic cell bodies and processes. Moreover, the anatomical distribution of these neuropeptides in

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great apes, such as chimpanzees, has not been studied to date. We used immunohistochemistry to identify cell bodies and fibers containing OT and AVP within the social behavioral neural network in postmortem tissue from humans (n=3), chimpanzees (n=3), and rhesus macaques (n=5). All species showed labeling for OT and AVP cell bodies in the paraventricular and supraoptic nuclei of the hypothalamus. Rhesus macaques showed a wider distribution of labeling for AVP than chimpanzees or humans, with dense cell bodies and fibers in the BNST as well as fibers in the lateral septum, amygdala, and PAG. Across the three species, labeling for OT was more restricted, being mainly localized to the PVN and SON of the hypothalamus. Our results suggest that primates differ from many rodent species (e.g., mice, rats, and voles), which have prominent AVP-containing cell bodies in the medial amygdala that send fiber projections to several forebrain areas. Our results also suggest that the distribution of AVP cell bodies and fibers may have been reduced over the course of evolution in great apes and humans. The distribution of oxytocin and vasopressin receptors in the three species as revealed with receptor autoradiography will also be discussed.

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### Growing up is hard to do: growth in urban and rural non-adults from Roman Britain

ANNA J. ROHNBOGNER

Archaeology, University of Reading

Linear growth is interpreted as a sensitive indicator of health (King and Ulijaszek, 1999), providing a valuable tool for exploring Romano-British childhood as an understudied subject in a time of major social and economic upheaval. Childhood growth is influenced by wide-ranging factors including urbanisation, infection, nutrition, socioeconomic status, physical activity patterns and biological stress (Bogin, 1999; Cameron, 2007).

A total of 637 long bone measurements were taken from 256 major urban, 333 minor urban and 48 rural non-adults (0-17 years), dating to the 1<sup>st</sup>-5<sup>th</sup> century AD. Using a Kolmogorov-Smirnov test (KS), mean femoral and tibial diaphyseal lengths were plotted against dental age after Moorrees et al. (1963a,b) in one year age categories and compared to healthy modern children (Maresh, 1955). Scatterplots for femoral lengths were compared by site type using a Kruskal-Wallis one-way ANOVA. Femoral growth was further evaluated by presence or absence of enamel hypoplasia, new bone formation and cribra orbitalia, and compared to post-medieval non-adults

from Christ Church Spitalfields, London using scatterplots and KS.

Growth between modern and Romano-British children did not differ statistically, and no differences were found in femoral lengths between rural and urban sites. Only enamel hypoplasia had a significant effect on femoral length, whereby early childhood stress impacted on height attainment during the adolescent growth spurt. Compared to the post-medieval sample, significantly shorter femora were observed in the Roman period. This may be a product of the interaction of both environmental and genetic factors impacting on the growth of Romano-British children.

*This research was funded by an AHRC studentship.*

### Revising the hypodigm of *Homo heidelbergensis*, a view from the Eastern Mediterranean

MIRJANA ROKSANDIC

Anthropology, University of Winnipeg

The hominin mandible BH-1 from the Middle Pleistocene cave of Mala Balanica suggested a possibility that human populations in this part of the continent were not subject to the process of Neanderthalization observed in the west. Paleontological and paleoanthropological evidence from the Balkans is reviewed in the context of the Eastern Mediterranean geographic entity. Current hominin fossil record of the early Middle Pleistocene in the region suggest that Europe was inhabited by two different populations, a population in the west of the continent with developed derived Neanderthal morphology, and a more variable population in the east characterised by a combination of plesiomorphous and synapomorphous traits. In order to continue using the nomenclature of *Homo heidelbergensis*, the current hypodigm needs to be revised to include only the specimens from the latter group.

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### An Evolutionary Perspective on Elective Cesarean Section

KAREN R. ROSENBERG<sup>1</sup> and WENDA R. TREVATHAN<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Delaware,

<sup>2</sup>Department of Anthropology, New Mexico State University

Despite a WHO recommendation that cesarean section rates should not exceed 15%, rates as high as 36% are reported for a number of countries. Although many surgical deliveries are performed for what may be deemed "good" medical reasons, the past 2 decades have also seen an increase in requests for cesarean section in the absence of medical indications, especially in some countries. A reason frequently cited by

women requesting cesarean section is fear of vaginal delivery. Recognizing that extreme fear and anxiety can interfere with normal birth, the view from evolutionary medicine argues that moderate fear of childbirth and the tendency to seek companionship are deeply rooted in human evolutionary history as a by-product of the restructuring of the pelvis associated with selection first for bipedalism and later for encephalization. These anatomical changes resulted in the infant emerging from the birth canal facing away from the mother, placing a premium on having another person present to assist in delivery. Benefits of assistance at birth and the emotional need for that assistance have probably been present in the human lineage for at least a million years. When this assistance is not available, as in many clinical settings, fear and anxiety may result from the unmet emotional needs of the parturient woman. This can often be alleviated by providing social and emotional support. This very "low-tech" remedy provides an alternative to a surgical intervention that has significant risks to both mother and infant, including epigenetic changes that may have transgenerational effects.

### Feeding and Locomotor Systems Differ in Joint Excursions

CALLUM F. ROSS<sup>1</sup>, MICHAEL C. GRANATOSKY<sup>1</sup>, ANDREA B. TAYLOR<sup>2</sup>, JOSE IRIARTE-DIAZ<sup>4</sup> and ERIC MCELROY<sup>3</sup>

<sup>1</sup>Organismal Biology and Anatomy, University of Chicago, <sup>2</sup>Department of Basic Science, Touro University, <sup>3</sup>Department of Biology, College of Charleston, <sup>4</sup>Department of Oral Biology, University of Illinois Chicago

Comparison of feeding and locomotor systems reveals differences in system design (form-function relationships). Here we focus on joint-angle excursions during cyclic feeding and locomotor movements. Joint-angle excursions were measured from nine mammal and four reptile species during chewing (18,325 cycles) and from 21 mammal and seven reptile species during quadrupedal walking gaits (1,329 cycles). On average, joint-angle excursions during chewing were lower (10°-20°) compared to excursions observed at the wrist (30°-50°), ankle (30°-40°), elbow (20°-50°), knee (20°-40°), shoulder (60°-80°), and hip (60°-80°). The greater joint excursions observed during locomotion are likely due to a combination of factors. During locomotion, increased angular excursion is linked with increased stride length, which in turn is associated with decreased energetic costs or increased speed. In contrast, feeding-system performance during chewing (as opposed to biting) may not relate to increases in gape, either because the energetic benefits of faster chewing or wider gapes may be negligible, or because any bolus size-related benefits of large gape during chewing are offset by decreased performance on the length:force or velocity:force

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curves of skeletal muscle. Another possibility is that, in comparison with the locomotor system, the muscle force vectors of the feeding system have relatively longer lever arms and are more orthogonally oriented to the long axis of the bone. The greater joint-angle excursions of the locomotor system are thus made possible by their shorter lever arms, but they come at the expense of torques compared to the feeding system.

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### Estimating age at death in subadults from metaphyseal width of lower limb long bones

CHIARA ROSSETTI<sup>1</sup>, MARTA LICATA<sup>2</sup>, GIUSEPPE ARMOCIDA<sup>2</sup>, ANDREA VERZELETTI<sup>1</sup> and ADELAIDE TOSI<sup>3</sup>

<sup>1</sup>Department of Medical and surgical specialties, radiological sciences and public health, University of Brescia, <sup>2</sup>Department of Biotechnology and Life Sciences, University of Insubria, <sup>3</sup>Department of Public Health, Experimental and Forensic Medicine, University of Pavia

Due to the poor conservation state of archaeological subadult skeletal remains, in particular regarding diaphysis fragmentation, it is not feasible to use conventional methods in order to estimate age at death (Maresh 1970; Ubelaker 1998). In addition, issues are also encountered in those bones which do not present a metaphysis-epiphysis fusion due to the young age of individuals. At present in literature there is little to no evidence of the direct use of metaphyseal width to estimate a subject's age. Therefore, we decided to verify if a correlation exists between these two parameters, choosing the lower limb as our area of interest and focusing on femur and tibia. The measurements of the metaphysis were extrapolated from radiological images acquired by the Department of Pediatric Radiology of Spedali Civili of Brescia. The study sample comprises of 200 individuals between 0 and 10 years of age. Regression models were applied to the measurements in order to derive prediction equations for estimation of age from metaphyseal width of femur and tibia. The analysis of our data showed the existence of a correlation between metaphyseal width of lower limb long bones and the real age of the individual. In addition, it is evident that, from the measurements of the metaphyseal width of fragmented limbs, it is possible to indirectly determine the diaphyseal length. Moreover, we have compared the correlation of diaphyseal length with individuals' age to current methods.

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### New Material of *Turkanapithecus* and *Simiolus* from West Turkana, Kenya

JAMES B. ROSSIE<sup>1</sup> and SUSANNE COTE<sup>2</sup>

<sup>1</sup>Anthropology, Stony Brook University, <sup>2</sup>Anthropology and Archaeology, University of Calgary

Three catarrhine taxa have been documented at the early Miocene localities of Moruorot and Kalodirr in West Turkana - *Afropithecus*, *Turkanapithecus*, and *Simiolus*. Both *Turkanapithecus* and *Simiolus* are known from only a handful of dentognathic specimens and some associated postcrania. New specimens discovered during our 2015 and 2016 field seasons at Kalodirr are attributed to *Simiolus* (a mandible) and *Turkanapithecus* (a mandible and associated hand/foot bones). These specimens are significant because they further document the morphology of these two poorly known taxa, allow us to re-assess the taxonomic affinities of previously collected specimens, and provide information on the biogeography and systematics of *Turkanapithecus*.

The new *Turkanapithecus* mandible allows us to confirm that the previously collected mandible KNM-MO 1 from Moruorot should also be attributed to *Turkanapithecus*; previously this taxon was known only from Kalodirr. Both mandibles display features reminiscent of nyanzapithecines, including a teardrop-shaped m3, deep lingual notch on m1, rounded and conical cusps, and a mesiodistally elongate p4 with tall trigonid.

Our new *Simiolus* mandible and *Turkanapithecus* hand bones come from the same stratigraphic horizon, clearly demonstrating the sympatry of these taxa for the first time at Kalodirr. *Turkanapithecus* and *Simiolus* are now documented from both Kalodirr and Moruorot, further supporting the similarity of these two catarrhine communities, while emphasizing their distinctness from penecontemporaneous communities at Buluk and Rusinga.

Excavation at Moruorot continues to yield additional elements of the previously reported *Simiolus* skeleton including several unworn teeth, which confirm the attribution of the specimen to that taxon.

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### Age, Exposure, and Disease: An Osteological Analysis of Three Juvenile Individuals from the Helton Site in the Lower Illinois River Valley

AMANDA ROSSILLO

Anthropology, Barnard College

At the Late Woodland/Emergent Mississippian site of Helton in the Lower Illinois River Valley, three individuals, HN46-47 S2-12, HN46-47 S2-13, and HN46-47 S2-10, were interred in individual limestone box graves in Stratum 2, between Mounds 46 and 47. For each individual, age at death estimates, taphonomic assessments, and pathological observations were employed to understand why they were awarded specialized mortuary treatment that was not seen elsewhere

at the site. The dental and osteological analyses revealed that all three individuals were less than three years of age at time of death. The remains of all three individuals showed minimal taphonomic wear, though HN46-47 S2-10 had been damaged postmortem due to the collapse of the limestone box. The pathological observations indicate periosteal new bone addition on the inner surface of the cranial vault along the sagittal sutures of HN46-47 S2-12 and HN46-47 S2-13, with HN46-47 S2-12 exhibiting evidence of cribra orbitalia in both eye orbits. Based on the degree of reintegration into the cortical surface, it appears that both individuals were actively healing from at least one pathological condition, while HN46-47 S2-12 also showed signs of active and completed healing. Because cribra orbitalia and periosteal new bone formation can result from a variety of conditions, including nutritional stress and infectious diseases, differential diagnoses cannot be made. While more research is needed to contextualize these findings within the relevant cultural framework, the results of this study provide crucial information that can be used to understand why these children were given specialized mortuary treatment.

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### A Pact of Not Forgetting: Understanding Medellín's Violent Past Through a Modern Documented Skeletal Collection

JESSICA E. ROTHWELL

School of Human Evolution and Social Change, Arizona State University

Documented skeletal collections have been used to create standards for "biological profiles" that have both forensic and archaeological applications. However, until recently, the social, political, and historical contexts of such collections and the lives of the people whom they represent have been underemphasized in the development of these standards. This study examines a modern documented skeletal collection from Medellín, Colombia with two main goals: first, to define how an imbalance between using collections as standards and understanding them in context leads to inherent biases, and second, to determine *who* the collection represents, with a specific interest in the identity characteristics of adolescents and young adults, who are normally underrepresented in documented collections.

Forty-nine males and seven females who died between the ages of 10 and 25 years from the osteological reference collection at the University of Antioquia were macroscopically evaluated for skeletal trauma and non-traumatic pathologies. Results indicate that most individuals suffered traumatic injuries associated with violent deaths and that many also display signs of poor health. Contextualized within the broader framework of the collection itself and the city of Medellín as a whole, these biases reflect patterns of violence concentrated in neighborhoods of low

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socioeconomic status, whose residents are in turn most likely to be interred in the cemeteries from which the collection is derived. Thus, the collection is not representative of Medellín as a whole, but rather the poverty and violence that inform on a particular chapter of Medellín's history.

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### The Upper Paleolithic human remains from the Troisième caverne of Goyet (Belgium)

HÉLÈNE ROUGIER<sup>1</sup>, ISABELLE CREVECOEUR<sup>2</sup>, ASIER GÓMEZ-OLIVENCIA<sup>3,4</sup> and PATRICK SEMAL<sup>5</sup>

<sup>1</sup>Department of Anthropology, California State University Northridge, <sup>2</sup>UMR 5199-PACEA, CNRS, Université de Bordeaux, <sup>3</sup>Dept. Estratigrafia y Paleontología, Euskal Herriko Unibertsitatea, <sup>4</sup>IKERBASQUE, Basque Foundation for Science, <sup>5</sup>Scientific Service of Heritage, Royal Belgian Institute of Natural Sciences

The Troisième caverne of Goyet yielded a rich archeological sequence ranging from the Middle and Upper Paleolithic (UP) to historical times. In 2008, we began to document the Paleolithic occupations of the Troisième caverne by reassessing the heretofore only partially studied collections recovered in the 19th and early 20th century. Implementing a multidisciplinary approach that included revising the human collections and conducting a systematic sorting of the faunal material, we updated the known human inventory and identified numerous new human remains. Direct radiocarbon dating of several of these remains showed that the human sample from Goyet corresponds to a mix of specimens from different time periods.

We will present a set of 25 modern human specimens that we attribute to three periods of the UP, namely the Aurignacian, Gravettian and Magdalenian. Although multiple archeological sites attest to the presence of humans in Belgium during the UP, Goyet is the first one thus far to have yielded human remains securely associated to this time period. They include fragmentary elements from the cranial and infracranial skeleton, and represent at least seven adults/adolescents and three juveniles of both sexes. Since genetic analyses of several of the UP remains have shown biological discontinuities between the successive UP occupations, we will compare their phenotypic and genetic variation. Our study brings new data on the biological diversity of UP modern humans from an area of Europe where no information has been previously available for this time period, and informs the population processes of early modern Europeans.

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### Mixed Effects of Modern Climate, Pleistocene Climate, and Anthropogenic Activity on Global Primate Diversity Patterns

JOHN J. ROWAN, IRENE E. SMAIL and KAYE E. REED

Arizona State University, Institute of Human Origins

Although previous research has implicated modern climate and environments as drivers of global primate diversity, the influence of other potentially important factors, such as paleoclimate and anthropogenic impact, remains poorly known. Pleistocene climate change resulted in major expansions and contractions of vegetation biomes and the primate communities that occupy them. Similarly, increasing anthropogenic impact paralleling human population growth since the Industrial Revolution has radically transformed the world's ecosystems. Here we use a global dataset of primate communities (>10,000 communities) to analyze the relative influence of modern climate, Pleistocene climate, and anthropogenic impact on community diversity and to decipher how the influence of these factors varies across continents. We compiled body mass and dietary data for 418 primate species and used these data to quantify functional diversity metrics for each primate community. We predicted functional diversity metrics from modern precipitation and temperature variables, Pleistocene precipitation and temperature anomalies, and anthropogenic impact indices using linear models. Full model results show that the combination of these predictors explains broad patterns of functional diversity in Africa ( $R^2=0.49$ ,  $p<0.001$ ), Asia ( $R^2=0.33$ ,  $p<0.001$ ), Madagascar ( $R^2=0.21$ ,  $p<0.001$ ), and South America ( $R^2=0.66$ ,  $p<0.001$ ), although their importance differs across continents. Anthropogenic impacts and modern and Pleistocene climate were equally important for Asia and South America, whereas Madagascar was most strongly influenced by Pleistocene climate change. Pleistocene precipitation change and modern precipitation were most important for Africa. Our findings have important conservation implications for forecasting the response of primate communities to anthropogenic land-use and climate change over the next century.

### Membership in a LGBT-Focused Organization Serves as a Buffer against Stigma: A Biocultural Approach to Stigma Stress

NICHOLAS D. ROY<sup>1</sup>, CAITLYN WALKER<sup>1</sup>, HAROLD ACOSTA<sup>2</sup>, SIERRA LAWSON<sup>3</sup> and CHRISTOPHER D. LYNN<sup>1</sup>

<sup>1</sup>Anthropology, University of Alabama, <sup>2</sup>Psychology, University of Alabama, <sup>3</sup>Religious Studies, University of Alabama

Experience of chronic stress is associated with a higher likelihood of mental illness. The minority stress model, as it relates to LGBT (Lesbian, Gay, Bisexual, and Transgender) populations, is composed of three parts: internalized homophobia, stereotype threat, and violence. While resilience against minority stress has been observed within supportive social groups, there is a lack of research on how stress from stigma can be resisted by LGBT groups. We hypothesize that LGBT-focused organizations inculcate greater attachment among group members, which provides a protective buffer against the adverse health effects of stigma that is stronger in LGBT-focused organizations than in organizations lacking a specific focus on LGBT interactions. We also predicted that LGBT members in an LGBT-focused student organization would have better reported mental health outcomes than LGBT members in a student organization with a focus not specific to LGBT issues. Our predictions draw on neuroanthropological theory regarding how stress from stigma becomes internalized and how social groups provide protection from the adverse health effects caused by stress from stigma. Data include self-reports ( $n=30$ ) correlating stress and social involvement among LGBT members of the two organizations. Preliminary analysis indicates that the personality trait openness to experience (OTE) predicts social involvement within the LGBT group and is a possible confound ( $\beta = .318$ ,  $p = .021$ ). Findings from this study will be important for understanding the biological mechanisms underlying social support and resilience within marginalized social groups.

*This study is not receiving funding.*

### Microbiome of Bone Marrow during Human Decomposition

NICHOLE RUBLE, PATRICK LEWIS and AARON LYNNE

Department of Biological Sciences, Sam Houston State University

Decomposition is a dynamic process driven by biotic and abiotic factors. Scavenging, weather, and climate, for example, can all impact decomposition rates. Recent studies utilize metagenomics, particularly the succession of bacterial communities, to estimate postmortem interval (PMI), but these methods too are subject

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to difficult to control variables. The interior of marrow-containing bones, however, is relatively protected from many of these variable, and while soft tissues may last for only weeks or days, many bones persist for months or years. Here we outline a novel methodology for sampling the microbiome of decomposing cadavers and summarize our preliminary results. We placed bodies at the Southeast Texas Applied Forensic Science (STAFS) facility at Sam Houston State and sampled them for 4 months. We sampled the femur, humerus, and ilium of three human cadavers (2 male and 1 female) using bone marrow biopsy needles. Left bones were sampled every 2 days and right ones every 10, as a control for contamination. We submitted all these samples for sequencing of the 16S rRNA to identify bacterial communities. Several challenges were encountered, such as difficulty sealing sampled bones, preventing insect contamination of the marrow cavities, and scavenger activity. Preliminary results, however, suggest that this method may be useful in estimating PMI with fewer external variables and for longer periods. As we take the data from 2016 and refine our methodology, we anticipate that information from marrow-containing bones can be used to better estimate the postmortem interval PMI and provide a useful tool for forensic investigators.

### The Use of the Pelvic Microbiome for PMI Estimation

LAUREN RUDIE, MEREDITH MANN and NICHOLE RUBLE

Biological Sciences, Sam Houston State University

Postmortem interval (PMI), or time since death, is critical for determining cause of death. Current estimation of PMI is derived primarily using bacteria-driven stages of decomposition and entomology. These methods are difficult as they are influenced by external factors including temperature, moisture level, season, and scavenger activity. Likewise, soft tissues generally last only weeks or days. Bones are protected from external environments and persist for weeks or months, extending their potential for estimating PMI. Here we utilized the protected marrow cavity of the pelvis to study bacterial succession throughout all stages of decomposition. Three cadavers were placed at the Southeast Texas Applied Forensic Science (STAFS) facility at Sam Houston State University where samples were taken from the left and right iliac crest over the past four months, using the right side as a control. Samples were collected from all three specimens using medical grade bone marrow biopsy needles. Each sample was labeled according to the day it was taken and the sampled side, then stored in sterile cryotubes and kept refrigerated at -20°C. The microbiota collected were analyzed using deep sequencing of 16S rRNA genes, as this specific gene is common among all bacteria. The

presence of marrow after four months suggest that this method could establish a more accurate PMI after extended periods of time. Preliminary results suggest that the microbiome of the pelvis may be an accurate predictor of PMI. This novel study could transform the methodology in which PMI is calculated, allowing for a more accurate estimation.

### Shape covariation of the human orbit and eyeball

ALEXANDRA RUEDELL

Biological Anthropology, Albert-Ludwigs-Universität Freiburg

Recent studies have shown that a higher prevalence of juvenile onset myopia (shortsightedness) exists in individuals with small orbital cavities. As an explanation it is hypothesized that the eyeball is located more anterior due to spatial demands leading to a deformation by the orbital rim. This forces the bulbus into an elongated shape which is the known cause for myopia. In this study, it is analyzed how orbital shape, rather than size, covaries with bulbus shape and position. A template mesh representing the bony orbital region was fitted onto 652 CT-scans representing the heads of European and Chinese males and females. Sixty-two manually placed landmarks along with 3000 surface semilandmarks were used for further analysis. The eyeball shape was captured with six manually placed landmarks. After a Procrustes fit including all landmarks, a partial least squares regression was performed. The results indicate that eyeball position strongly covaries with orbital shape. The main shape differences in the orbital cavity are located in its posterior part. A narrower orbital cavity accompanies a more anteriorly placed eyeball. This effect is increased by a flatter upper face which leads to less pronounced nasal bones and a relatively retracted supraorbital region. In wider orbital cavities, the supraorbital and glabella region are more pronounced. In these cases, the bulbus is placed more posteriorly behind the orbital rim. Shape differences between relatively anteriorly and posteriorly positioned eyeballs, though, are only minor with the anteriorly located bulbus being slightly elongated.

### Skeletal aging in mountain gorillas

CHRISTOPHER B. RUFF<sup>1</sup>, M BURGESS<sup>1</sup>, ANTOINE MUDAKIKWA<sup>2</sup> and SHANNON MCFARLIN<sup>3</sup>

<sup>1</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>2</sup>Department of Tourism and Conservation, Rwanda Development Board, <sup>3</sup>Department of Anthropology, George Washington University

Bone loss with aging, and consequent increased risk of fracture (osteoporosis), is ubiquitous in modern human populations. Only very limited information is available on skeletal age-related

changes in wild nonhuman primates, particularly great apes. In this study we report results of a cross-sectional study of bone structural changes with aging in wild Virunga mountain gorillas (*G. beringei beringei*). A total of 32 skeletons (16 males and 16 females) of individuals ranging in age from 10.7 to 43 years were scanned using peripheral quantitative CT in the mid-diaphyseal regions of the femur, tibia, humerus, radius, and ulna, with section properties determined using the system software. In 25 cases ages were known (to within  $\pm 1.5$  years) and in seven cases were estimated from dental wear standards developed from this sample (SEE = 3.3 years).

With aging, relative cortical thickness (%CA) declined significantly in both sexes and all bones, except the humerus in males, primarily as a result of medullary expansion. There was also a tendency for periosteal expansion with aging (significant in some sections). Because of this outward expansion of the cortex, no age-related declines (and some significant increases) in bending/torsional strength (polar section modulus,  $Z_p$ ) were observed. There were no significant differences in age-related patterns in males and females. These results are very similar to those observed among aging humans, except for a lack of accelerated bone loss in older females, which we attribute to late and inconsistent evidence for menopause in gorillas.

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### Radiological and Forensic Re-evaluation of the Cause of Death of the Iceman, c. 5300 BP

FRANK RUHLI<sup>1</sup>, PATRIZIA PERNTNER<sup>2</sup> and OLIVER PESCHEL<sup>3</sup>

<sup>1</sup>Institute of Evolutionary Medicine, University of Zurich, <sup>2</sup>Department of Radiology, Bolzano Hospital, <sup>3</sup>Institute of Forensic Medicine, University of Munich

The Copper Age Iceman (South Tyrol Museum of Archeology; "ötzi") is one of the most famous human mummies in the world. Many studies have focused on his health and on his very final moments in life since his discovery in 1991. However, his cause of death is still being controversially debated being attributed e.g. to brain injuries or a lethal laceration of the left subclavian artery by an arrowhead. The aim of this presentation is to provide new radiological and forensic evidence on his violent cause of demise. The latest available imaging data of the Iceman have been analyzed with a particular focus on comparative forensic interpretation. The extent of internal bleeding has been newly calculated to be c. 110ml, thus an internal hematoma only as main cause of death is rather unlikely. Furthermore, re-analysis of the multiple skull lesions do not provide sufficient evidence for

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a local circumscript and punctual deadly blunt trauma. Based also on comparative modern forensic data, one can assume now that the laceration of the subclavian artery lead within minutes to hours to a massive mostly external trauma, and in combination with hypothermia, to his death. Additional data on possible functional implications, on a possible pseudo-aneurysm, estimated time of survival and future examinations to be planned will be provided too. The novel results will be presented also in the context of a larger, ongoing interdisciplinary investigation of this unique murder case.

*Mäxi Foundation*

### Cancellous bone density in age-sorted atelines

JACQUELINE RUNESTAD CONNOUR<sup>1</sup>, KAYLA M. NIDA<sup>2</sup> and KENNETH E. GLANDER<sup>3</sup>

<sup>1</sup>Biological and Allied Health Sciences, Ohio Northern University, <sup>2</sup>Department of Forensic Sciences, Mercyhurst University, <sup>3</sup>Evolutionary Anthropology, Duke University

This study compares cancellous bone density in *Alouatta*, *Lagothrix*, and *Ateles* juvenile and adult wild-shot specimens. It was predicted that females would show reduced bone density with increasing age, and that *Ateles* would show greater bone density due to more suspensory behavior.

Relative age stages were assigned based upon teeth and epiphyseal fusion. Humeri and femora were radiographed with an epoxy resin step-wedge. *ImageJ* (NIH) was used to collect optical density data from scanned X-rays. Following step-wedge calibration, equations were generated to estimate average bone mass for transects across the femoral head mediolaterally and below the humeral tubercles anteroposteriorly. Diameters oriented ninety degrees to these transects were measured, also. Total sample size was eighty-nine, with males and females analyzed separately.

Bone density was estimated by dividing average bone mass for each transect by the corresponding diameter. *Systat 13* performed statistical analyses, including two-sample t-tests and linear regressions of variables on age stages. Only significant results are reported.

Among genera, *Ateles* femoral head diameter and average bone mass are greater. This may reflect slightly greater *Ateles* body size or greater articular mobility. Bone density for *Ateles* does not differ from other groups.

Humeral subtubercular bone density decreases with increasing age in males and females, despite increasing diameter. This was expected for females, but not males. This may be an effect of remodeling near epiphyseal plates, or age-related bone loss. Examination of other bone sites may help clarify this pattern.

### The Evolution of Foramen Magnum Position and Orientation in Anthropoids

GABRIELLE A. RUSSO<sup>1</sup>, E. CHRISTOPHER KIRK<sup>2,3</sup>, JORDAN S. GUERRA<sup>1</sup> and JEROEN B. SMAERS<sup>1</sup>

<sup>1</sup>Department of Anthropology, Stony Brook University, <sup>2</sup>Department of Anthropology, The University of Texas at Austin, <sup>3</sup>Jackson School Museum of Earth Sciences, The University of Texas at Austin

An anteriorly-positioned and anteroinferiorly-facing foramen magnum distinguishes humans from other apes, in which the foramen magnum is positioned and faces more posteriorly. Here, we estimate how foramen magnum position (FMP) and orientation (FMO) evolved in anthropoids to shed light on the human condition and evaluate the extent to which the evolution of positional behaviors and brain size explains observed morphological patterns. Three-dimensional landmark data and lateral photographs were collected from 732 crania (98 species). We derived commonly cited measures of FMP (bicaudal index [BI], Weidenreich index [WI]) and FMO (basion-opisthion plane relative to Frankfurt Horizontal [BOFH], basion-opisthion-inion angle [BOIA]). Trait macro-evolutionary configurations were mapped using an Ornstein-Uhlenbeck modeling approach with a least-squares procedure to detect phenotypic shifts along individual branches, and a phylogenetic lasso procedure to regularize shift configurations across the tree. Results reveal disparate phenotypic shifts in FMP based on whether the fixed frame of reference for assessment is located anteriorly (as in BI) or posteriorly (as in WI). Humans evolve toward the end of the phenotypic spectrum representing an anterior FMP, but for BI, are surpassed by *Bunopithecus hooock*. For BOIA and BOFH, humans evolve toward the middle and extreme end of spectra, respectively. Phylogenetic ANOVAs and evolutionary model fitting approaches indicate that the influences of trunk posture, locomotion, and brain size on observed morphological patterns are nonsignificant across the sample. Results have implications for understanding how metric choice impacts interpretations of foramen magnum morphology and provide a framework for discussions concerning selective pressures throughout hominin evolution.

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### The relationship of knee rotation to lateral meniscus shape and attachments in hominoids

AIDAN A. RUTH

Pathology and Anatomical Sciences, University of Missouri

The posterior horn of the lateral meniscus (PHLM) is a feature unique to humans and may be an adaptation to limiting movement of the LM during flexion and extension of the knee. I tested

an alternative hypothesis: That the posterior horn of the LM is the result of antero-posterior lengthening of the femoral condyles (FCs) and thus the anterior insertion of the LM. Results of a one-way ANOVA reveal that *Homo* has longer FCs than *Pongo* (which has a semilunar meniscus), *Gorilla*, and *Pan* (which both have ring-shaped menisci) ( $F(3,57) = 8.60, p < 0.001$ ) and support the hypothesis. To further explore differences in meniscal shape, I also tested the hypothesis that knee mobility affects meniscus shape. A second one-way ANOVA found significant differences between groups ( $F(3,68) = 14.526, p < 0.001$ ) in the amount of knee rotation (estimated by a ratio between medial and lateral FCs). Further post-hoc testing revealed that *Gorilla* and *Pan* did not differ significantly. Additionally, *Pongo* did not differ significantly from either *Pan* or *Homo*, despite their differences in meniscal shape. These results pose the question: What caused the meniscus in *Pongo* to evolve from the presumed ancestral ring-like condition to its present semilunar form? My results may support the hypothesis that animals with more rotation of the knee have more mobile (ring-shaped) menisci. However the LM in *Pongo* illustrates that meniscus shape is a complex phenomenon with many contributing factors, including knee geometry, rotation of the knee, and developmental variables.

### Insulin it to Win It: Patterns, Causes, and Consequences of Insulin Production during the Marmoset Monkey Pregnancy

JULIENNE RUTHERFORD<sup>1</sup>, LAREN RIESCHE<sup>1</sup>, TONI ZIEGLER<sup>2</sup>, CORINNA ROSS<sup>3</sup>, AUBREY SILLS<sup>4</sup>, DONNA LAYNE COLON<sup>5</sup>, VICTORIA DEMARTELLY<sup>1</sup> and SUZETTE TARDIF<sup>5</sup>

<sup>1</sup>Women, Children, and Family Health Science, University of Illinois at Chicago, <sup>2</sup>WNPRC, University of Wisconsin, <sup>3</sup>Biology, Texas A&M University - San Antonio, <sup>4</sup>Barshop Institute, University of Texas Health Science Center - San Antonio, <sup>5</sup>SNPRC, Texas Biomedical Research Institute

The insulin pathway regulates placental and fetal growth across gestation. The extent to which maternal insulin varies with respect to maternal energetic status and pregnancy outcomes in the common marmoset monkey (*Callithrix jacchus*) is not known. The marmoset is an increasingly important model of fetal programming and provides an opportunity for exploring the complex interaction among maternal condition, hormone production, and fetal outcomes. We report serum insulin from 18 pregnancies of 11 marmoset females, carrying litters ranging from two to four offspring of varying viability at birth to describe insulin profiles across gestation in relation to maternal weight and placental weight. Serum insulin and maternal weights were measured at day 60, 90, and 120 of a 143-day gestation. Placental weights were collected at birth. Insulin values increased dramatically across gestation, ranging from 1.5 to 62.7  $\mu\text{U/mL}$  suggesting

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enhanced mobilization of glucose. Insulin at d. 60 of gestation was significantly positively associated with placental weight at birth ( $r^2=0.65$ ,  $p=0.005$ ). There is considerable variation between females, as well as within females between pregnancies. For example, comparing d. 60 to d. 120, insulin values increased an average of 58% but showed tremendous variation ranging from -20% to 155%. Maternal characteristics will be explored as predictors of variation in insulin dynamics, as will consequences such as litter size, sex, birth weight, and viability of offspring. Understanding the maternal causes and fetal consequences of these dynamics can improve birth outcomes and sequelae relevant to developmental programming.

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### Epigenetic pathways of intergenerational phenotypic inertia in birth weight: Evidence from mothers in Cebu, Philippines

CALEN P. RYAN<sup>1</sup>, MEAGAN J. JONES<sup>2</sup>, JULIA L. MACISAAC<sup>2</sup>, ALEXANDER MORIN<sup>2</sup>, JUDITH B. BORJA<sup>3</sup>, MICHAEL S. KOBOR<sup>2</sup>, CHRISTOPHER W. KUZAWA<sup>1</sup> and THOMAS W. MCDADE<sup>1</sup>

<sup>1</sup>DEPARTMENT OF ANTHROPOLOGY and INSTITUTE FOR POLICY RESEARCH, NORTHWESTERN UNIVERSITY, <sup>2</sup>CENTRE FOR MOLECULAR MEDICINE AND THERAPEUTICS, BC CHILDREN'S HOSPITAL, UNIVERSITY OF BRITISH COLUMBIA, <sup>3</sup>OFFICE OF POPULATION STUDIES, UNIVERSITY OF SAN CARLOS

Birth weight (BW) is a strong predictor of infant morbidity and mortality, as well as of child and adult health and risk for metabolic disease. Maternal BW explains a greater proportion of the variation in offspring BW than paternal BW, suggesting the involvement of factors other than autosomal genetic variation. Pathways for transmitting the disproportionate contribution of maternal BW to offspring BW are unclear, but could involve maternal epigenetic states that directly or indirectly influence the expression of genes involved in offspring growth or metabolism. To test this hypothesis, we examined genome-wide methylation profiles from whole peripheral blood in ~400 Filipino women from Cebu, Philippines in relation to her own BW and body mass index (BMI) at birth, as well as the BW of her offspring. We examined each site independently using linear regression, and also applied a linear-mixed model approach to define and identify differentially-methylated regions (DMRs). Because of their role in developmental programming and resource allocation, we also ran analyses on a subset of known and predicted imprinted genes. After controlling for false discovery rate, we did not find strong evidence that BW predicts methylation in adult female peripheral blood samples, nor that maternal blood methylation explains offspring BW. While

several CpG sites reached statistical significance for both EWAS and DMR analyses, the biological significance of these findings in relation to BW variation is still unclear. We will discuss the relevance of our findings, and consider alternative hypotheses for the intergenerational transmission of human BW.

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### Trabecular bone structural variation in the hominin femoral head

TIMOTHY M. RYAN<sup>1,2</sup>, KRISTIAN J. CARLSON<sup>3,4</sup>, LILY J. DOERSHUK<sup>1</sup>, ADAM D. GORDON<sup>5</sup>, TEA JASHASHVILI<sup>6</sup>, COLIN N. SHAW<sup>7</sup> and JAY T. STOCK<sup>7</sup>

<sup>1</sup>Department of Anthropology, Pennsylvania State University, <sup>2</sup>Center for Quantitative Imaging, Pennsylvania State University, <sup>3</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California, <sup>4</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>5</sup>Department of Anthropology, University at Albany, SUNY, <sup>6</sup>Georgian National Museum, <sup>7</sup>PAVE Research Group, Department of Archaeology and Anthropology, Division of Biological Anthropology, University of Cambridge

Recent studies have documented trabecular bone structural variation in modern humans and fossil hominins; however, the pattern of variation within and between species, and the role of declining mobility and other factors in driving this variation remains unclear. This study assesses phenotypic variation in femoral head trabecular bone structure across extant and extinct hominid species. Proximal femora of 150 individuals from 10 modern human populations, 14 fossil hominin specimens representing four species (*A. africanus*, *P. robustus*, *H. neanderthalensis*, Late Pleistocene *H. sapiens*), and 29 individuals from three extant great ape species (*Pan*, *Gorilla*, *Pongo*) were microCT scanned. Modern human groups represent a behavior/mobility gradient spanning forager, early agricultural, Bronze Age, Medieval, and post-industrial populations. For each individual, a central volume of interest was extracted from the femoral head and trabecular structure was analyzed using BoneJ. Results indicate significant structural variation within modern humans, largely reflecting differences in mobility. Foragers and early agriculturalists generally have higher bone volume fraction (BV/TV) and trabecular thickness (Tb.Th) than other less mobile groups ( $p<0.05$ ). The main exception are Inuit who have relatively low BV/TV and Tb.Th, more similar to sedentary populations. Australopithecids have robust trabecular bone similar to great apes, while Pleistocene hominins, including Neanderthals, have less robust trabecular bone, comparable to more sedentary human populations. Low bone mass in Neanderthals and Inuit suggest diet and/or thermoregulation may play important roles in determining bone mass

in these groups. Skeletal variation within genus *Homo*, including within *Homo sapiens*, appears more complex than previously understood.

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### Trace element evidence for trophic level in extant mammals from Laikipia, Kenya: implications for eastern African fossil hominin diet reconstructions

CHRISTINA RYDER<sup>1</sup>, RHONDA QUINN<sup>2,3</sup>, JASON LEWIS<sup>4,5</sup>, BRIANA POBINER<sup>6</sup> and OGETO MWEBI<sup>7</sup>

<sup>1</sup>MA Program in Human Skeletal Biology, Department of Anthropology, New York University, <sup>2</sup>Department of Sociology, Anthropology & Social Work, Seton Hall University, <sup>3</sup>Department of Earth and Planetary Sciences, Rutgers University, <sup>4</sup>Department of Anthropology, Stony Brook University, <sup>5</sup>Turkana Basin Institute, <sup>6</sup>Human Origins Program, Department of Anthropology, Smithsonian Institution, <sup>7</sup>Department of Osteology, National Museums of Kenya

Trace element analysis (Sr/Ca, Ba/Ca, Mg/Ca) has been utilized to gauge diet in fossil hominins. Higher trophic space leads to the biopurification of trace elements relative to calcium resulting in lower ratios in carnivorous animals relative to herbivores. Previous work has characterized South African ecosystems and has been used to infer meat consumption in australopithecines and paranthropines. Trace element ratios have not yet been reported from eastern African hominin and mammalian modern or fossil ecosystems. We assert that prior to the application to eastern African fossils, a study of eastern African extant mammals from modern ecosystems with analogous floral and faunal community structures to fossil habitats is warranted. Here we analyze Sr/Ca, Ba/Ca, and Mg/Ca from bulk enamel of 92 individuals representing 30 extant mammal species with known feeding ecologies from the Laikipia District, Kenya. Diet categories include C<sub>4</sub> grazers, C<sub>3</sub> browsers, mixed C<sub>3</sub>-C<sub>4</sub> herbivores, carnivores, and omnivores. We found that Sr/Ca ratios of carnivores, omnivores and mixed C<sub>3</sub>-C<sub>4</sub> herbivores are significantly lower than those of C<sub>3</sub> browsers and C<sub>4</sub> grazers. Unlike the South African findings, C<sub>3</sub> browser and C<sub>4</sub> grazer Sr/Ca ratios do not differ from one another. C<sub>4</sub> grazers and mixed C<sub>3</sub>-C<sub>4</sub> herbivores show the highest Mg/Ca ratios, C<sub>3</sub> browsers the lowest, and carnivores/omnivores intermediate ratios. Ba/Ca ratios are highest in C<sub>4</sub> grazers followed by C<sub>3</sub> browsers, mixed C<sub>3</sub>-C<sub>4</sub> herbivores, omnivores, and finally carnivores. Since these patterns differ from South African ecosystems, a comparable fossil mammalian study should be conducted before eastern African hominin trace elements are interpreted.

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### Attention to Social Grooming among Immature East African Chimpanzees (*Pan troglodytes schweinfurthii*) of the Kanyawara Community at Kibale National Park

KRIS SABBI<sup>1</sup>, MELISSA EMERY THOMPSON<sup>1,2</sup>, MARTIN N. MULLER<sup>1,2</sup>, ZARIN MACHANDA<sup>2,3</sup>, EMILY OTALI<sup>2</sup> and RICHARD W. WRANGHAM<sup>2,4</sup>

<sup>1</sup>Anthropology, University of New Mexico, <sup>2</sup>Board of Directors, Kibale Chimpanzee Project, <sup>3</sup>Anthropology, Tufts, <sup>4</sup>Human Evolutionary Biology, Harvard

Recent developmental studies of chimpanzees (*Pan troglodytes schweinfurthii*) argue that sex differences in adult sociality may be rooted in mothers adjusting their social strategies when they have sons versus daughters. Underlying differences in attention to and modeling of social interactions could exacerbate differential social exposure to encourage diverging social strategies. In this case immatures' attention to social interactions should reflect adult social patterns. As adult males are more gregarious and groom peers more often than females, young males should spend more time watching grooming bouts between nearest neighbors and be more likely than females to begin grooming immediately following exposure. To test this, we video-recorded immature chimpanzees at Kanyawara (n=24) in Kibale National Park, Uganda, for two minutes immediately at the start of a grooming bout between their nearest neighbors. We then scored the amount of time that focals spent watching (TSW) their neighbors grooming and whether or not the focal groomed a social partner after watching their neighbor. There was no sex difference in TSW (diff=1.32, p=0.39). Males were more likely to groom immediately following exposure (logistic regression, Int=-3.39, p<0.01;  $\beta_{sex}=4.09$ , p=0.03) and likelihood of grooming increased with age ( $\beta_{age}=0.87$ , p<0.01). Sex also interacted with TSW such that males that watched longer were even more likely to groom ( $\beta_{sex*TSW}=0.08$ , p=0.03). Thus males seemed to be more sensitive to social exposure than females, supporting the conclusion that developing sex differences in chimpanzee behavior may be shaped not only by differential social exposure but also underlying difference in attention.

*This project supported by the Wenner-Gren Foundation, Nacey P. Maggioncalda Foundation, American Philosophical Society, and the Leakey Foundation.*

### The Use of Geometric Morphometrics to Identify Distinct Mortuary Components at Koster Mounds

LITA SACKS

Anthropology, Indiana University

Geometric morphometrics represents an improvement over traditional metrics in bioarchaeological studies due to the focus on shape rather than size and the improved ability to

measure structures of biological significance. Here, geometric morphometrics is applied to Koster Mounds, a skeletal series of unclear chronology, to assess the masticatory morphology of seemingly distinct burial components characteristic of Late Archaic (5000 to 3000 BP) and Late Woodland (1500 to 1000 BP) groups. Because new food processing technologies that reduced jaw loading arose between these periods, masticatory morphology can be used as a non-destructive proxy for temporal affiliation. This study of the Koster Mounds mandibles (N=56) is part of a larger project to place Koster Mounds within the archaeological context of the Lower Illinois River Valley using cranial morphology, dental wear, dental non-metric traits, and overall patterns of paleopathology. There are statistically significant differences in mandibular morphology by sex, burial position, and burial depth. Individuals buried in graves beneath the original ground surface are morphologically distinct from those buried on the original ground surface or above it within the fill of constructed mounds. This finding indicates mounds were built atop pre-existing cemeteries corresponding to an earlier group with a distinct dietary loading regime. Additional components of this project will expand the morphological findings and determine whether the later burials represent descendants of the earlier group renewing their own social memory or a distinct group co-opting the mortuary landscape of others.

### Mobility and trabecular bone variation in the human foot

JAAP P. SAERS<sup>1</sup>, COLIN N. SHAW<sup>1</sup>, TIMOTHY M. RYAN<sup>2,3</sup> and JAY T. STOCK<sup>1</sup>

<sup>1</sup>Division of Biological Anthropology, University of Cambridge, <sup>2</sup>Department of Anthropology, Pennsylvania State University, <sup>3</sup>Center for Quantitative Imaging, EMS Energy Institute, Pennsylvania State University

Structural properties of trabecular bone may provide useful proxies for the interpretations of habitual behaviour among past populations and fossil species, but we require a better understanding of the developmental and mechanical influences on trabecular morphology. Our ability to meaningfully interpret trabecular variation depends on the extent to which trabecular bone morphology is integrated throughout the postcranium, or locally variable in response to joint-specific loading.

We compare trabecular structure in seventeen volumes of interest throughout the talus, calcaneus and first metatarsal between two mobile (n=40) and two sedentary (n=40) archaeological populations. We determine whether trabecular structure corresponds to inferred behavioural differences between populations, and to sexual division of labour within populations.

Both mobile populations are significantly more robust, displaying a higher bone volume fraction with thicker, more closely packed, and less interconnected trabecular structures throughout the foot. Patterns of variation in trabecular properties between volumes of interest are generally similar between populations, with a morphological signature of mobility superimposed upon them.

Previous work has found significant sexual dimorphism in femoral diaphyseal rigidity in three populations included in this study. However, few significant differences are observed in trabecular structure between males and females after correcting for the effects of body mass. The mechanisms behind the lack of sexual dimorphism in trabecular relative to cortical bone are not understood. Further experimental work is required to investigate potential sex-differences in trabecular bone modelling.

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### Postcranial Robusticity of Two Precolonial Brazilian Coastal Shellmound Builders Groups Relative to Differences on Daily Activities and Mobility

ADILSON D. SALLES<sup>1,3</sup>, MÔNICA KONSQUIER<sup>1</sup>, ELISE T. TONOMURA<sup>2</sup> and ANDREA LESSA<sup>1</sup>

<sup>1</sup>Antropologia, Universidade Federal do Rio de Janeiro, <sup>2</sup>Radiologia/Faculdade de Medicina, Universidade Federal do Rio de Janeiro, <sup>3</sup>Instituto de Ciências Biomédicas, Universidade Federal do Rio de Janeiro

Our objective is to investigate differences in daily activities and mobility of two precolonial shellmound builders from the Brazilian southeast coast, through the analysis of the geometrical properties of the humerus and femur.

The samples involved 12 adults individuals (M=6; F=6) from oceanic island Ilhote do Leste (IL) and 15 adults individuals from Zé Espinho (ZE) adapted to mangrove environment.

Studies have revealed greater difficulties in terrestrial and marine mobility and an intense production of lithic artifacts in the IL. Moreover, the female individuals of the IL have showed a high demands mechanical in daily activities.

Humeral and femoral geometric properties were analyzed through cross-sections images (CT) of the mid-distal level of the humerus and mid-shaft and subtrochanteric levels of the femur. In each section, cortical and medullary areas, and mechanical strength to bending (Imax, Imin) and torsional (J) loads were calculated.

Higher levels of humeral and femoral robusticity were observed in IL individuals. Female IL individuals were involved with high level of physical

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activity. The higher humeral robusticity in male IL individuals was related to intense production of lithic artifacts and rowing in ocean. Humeral robusticity in female was associated to food processing. The higher level of the femoral robusticity in male IL individuals was associated to exploration to terrestrial space in high terrain reliefs, in comparisons with ZE group adapted to mangrove space.

Thus, our study, using quantitative methodology, revealed differences in robusticity between these two groups relative to adaptations to distinct environments.

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### Evidence for Euclidean maps in wild western gorillas (*Gorilla gorilla*)

ROBERTA SALMI<sup>1</sup>, ANDREA PRESOTTO<sup>2</sup> and DIANE M. DORAN-SHEEHY<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Georgia, <sup>2</sup>School of Natural Sciences and Mathematics, Stockton University, <sup>3</sup>Department of Anthropology, Stony Brook University

Primates live in complex environments with unpredictable spatial and temporal distribution of resources, which is hypothesized to enhance selection for improved spatial cognition. Two mechanisms are proposed to explain how animals find resources in their environment: "the network system", the repetitive use of the same paths leading to nearby/visible resources, and "the Euclidean system", in which individuals are able to navigate to specific out-of-sight targets from any direction, creating new paths and shortcuts when revisiting them. To investigate which orientation system gorillas use when navigating their environment, we create route maps (using ArcGis10.3) based on two consecutive years of group location and resource use data (20139 GPS points taken every 15 minutes during 643 daily follows) from one group of western gorillas at the Mondika Research Center, Republic of Congo. Results indicate that gorillas often use variable (rather than repetitive) paths to reach out-of-sight resources. Additionally, a high proportion of nest sites and fruit trees visited (52% and 44% respectively) were far from the habitual paths at distances greater than those based on the visibility assumed for gorillas. Finally, the most frequently used routes in one year differed from those in the subsequent year. Together these results suggest that gorillas have precise knowledge of resources' location and directed and adjusted their daily paths according to resource availability, rather than limiting travel to specific paths. Thus, western gorillas, in contrast to spider and woolly monkeys, but like humans, chimpanzees and black capuchins, use a Euclidean navigation system.

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### Infracranial variability among the Magdalenian people of southwestern France

MATHILDE SAMSEL<sup>1</sup>, CHRISTOPHER J. KNÜSEL<sup>1</sup> and SEBASTIEN VILLOTTE<sup>2</sup>

<sup>1</sup>PACEA UMR 5199, Université de Bordeaux, <sup>2</sup>PACEA UMR 5199, CNRS

Studies on skeletal morphology and ancient DNA suggest that the Late Glacial Maximum (LGM, ca. 23,000 to 19,000 cal. BP) had a major impact on the behavior, morphological features, and population composition of European populations. In southwestern France, four primary burials are directly dated to 19,500-18,000 cal. BP and attributed to the Middle Magdalenian (MM): Chancelade, Lafaye, Laugerie Basse 4 and Saint-Germain-la-Rivière. The Cap Blanc burial, although indirectly dated at present, is likely to date to the MM as well. To characterize these 'transitional' individuals, we compare their infracranial variability to a pre-LGM Gravettian sample (ca. 33,500 to 23,000 cal. BP, n=10) and a post-LGM Epipaleolithic sample (ca. 14,000 to 11,500 cal. BP, n=11). We calculated four ratios from a set of eight long bone external measurements and analyzed them using multivariate statistics (PCA). MM individuals display a humeral diaphyseal index appearing intermediate, a femoral shape with lower pilastral and diaphyseal robusticity indices as well as a high cnemic index for the tibia. In conclusion, the MM sample follows the pattern of an increasing relative hypertrophy of the humeral midshaft throughout the Late Pleistocene. A correspondence between femur length and robusticity is supported. Overall, MM people from southwestern France display an intermediate infracranial morphology, which suggests a more complicated picture of behavioral variation and morphological adaptations to environmental and climatic fluctuations that accompanied the Late Pleistocene peopling of Europe.

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### Adolescent male chimpanzees form strong and differentiated social bonds with maternal brothers and old adult males

AARON A. SANDEL

Department of Anthropology, University of Michigan

Social bonds play an important role in the lives of adult primates. These relationships feature prominently in adult male chimpanzees, who form strong and enduring bonds with maternal brothers and non-relatives, especially males of similar age and rank. Social bonds facilitate cooperation as male chimpanzees form coalitions while competing for dominance status. Males

who achieve high rank, in turn, reproduce more than do lower ranking individuals. Despite the significant fitness consequences of social bonds for adult male chimpanzees, little is known about their development. If bonds are only important for the acquisition and maintenance of rank, they are likely to form when male chimpanzees start vying for status as adults. If, however, social bonds serve other purposes, they may arise earlier, during adolescence. To investigate these possibilities, I studied the social relationships of ten adolescent and eight young adult male chimpanzees at Ngogo, Kibale National Park, Uganda. To assess bonds, I created dyadic sociality indices based on associations, proximity, and grooming. Adolescent males formed strong social bonds as often as did young adults. Relatedness affected the formation of bonds, as maternal brothers forged strong ties with each other. In contrast to the pattern displayed later in adulthood, however, adolescent and young adult males formed bonds with old adult males instead of their peers. Old adult male chimpanzees may be particularly attractive social partners because they were tolerant of younger males. Future studies should investigate whether social bonds formed by male chimpanzees help buffer against stress as they transition to adulthood.

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### Morphological Changes and Expansion in New Kingdom Egypt and the Levant

KAITLYN E. SANDERS

Anthropology, Purdue University

The Ancient Egyptian empire expanded significantly during the New Kingdom period, establishing political control in Nubia and in an area of the eastern Mediterranean known as the Levant. The renewed militaristic strength of the New Kingdom allowed Egypt to take hold of lands in the Levant, setting up vassal states controlled by Egyptian colonists. Cranial morphology of populations from Egypt and the Levant was analyzed in an effort to understand the results of the Egyptian expansion on the biological relationship between Egyptian and Levantine peoples.

Craniometric data of adults from Egyptian pre-New Kingdom and New Kingdom sites as well as from the site of Lachish, Israel were gathered from archival literature and analyzed using the multivariate techniques of Canonical Variates Analysis and Cluster Analysis. Males and females were analyzed separately to detect any sex-related morphological variation. Populations from New Kingdom Egypt were closer in biological distance to Lachish than those from pre-New Kingdom dynasties. However, sex-related morphologies served as the most effective way

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to separate groups. Males, regardless of region or time period, were more similar to other males than to any female group. When only shape variables were considered, the females from Lachish clustered with the male groups rather than with the other female populations. Overall, these results suggest that New Kingdom Egyptians were closely related to Levantine peoples and also reveal a distinction between Egyptian and Levantine females, which may reflect differences between the sexes in level of interaction during this period of expansion.

### Patterns of Variation in the Oral and Gut Microbiomes of Traditional Populations

KRITHIVASAN SANKARANARAYANAN<sup>1</sup>, RAUL TITO<sup>2</sup>, ALEXANDRA OBREGON-TITO<sup>2</sup>, LUIS MARIN-REYES<sup>3</sup>, CHRISTINA WARINNER<sup>2,4</sup> and CECIL LEWIS JR.<sup>2</sup>

<sup>1</sup>Microbiology and Plant Biology, University of Oklahoma, <sup>2</sup>Anthropology, University of Oklahoma, <sup>3</sup>Instituto Nacional de Salud, <sup>4</sup>Max Planck Institute for the Science of Human History

Recent changes in human lifestyle, particularly the shift to industrial food production strategies and sanitized environments, is thought to impact the diversity of our microbiomes. While loss of microbial diversity has been typically associated with 'dysbiosis', it is important to understand how this loss manifests within the unique ecologies that comprise our microbiome.

Here, we examined the oral and gut microbiomes of four populations from Peru following three different lifeways: hunter-gatherers from the San Mateo region, highland farmers from Tunapuco, and two coastal communities from the Ica district. Briefly, we generated microbial community profiles using targeted amplification of the 16S rRNA gene (V4 region), followed by high throughput Illumina sequencing, and clustering of quality filtered reads into Operational Taxonomic Units (OTU, 97% sequence similarity). We compared these microbial communities to those generated from urban and rural populations following an industrial agriculture lifestyle from Oklahoma, USA.

Overall, both oral and gut microbiomes showed a decrease in microbial richness in association with industrial lifestyles. However, within the gut microbiome, this pattern was driven by the loss of entire genera, while the loss of diversity within the oral microbiome occurred at the OTU level. Additionally, while dietary composition and subsistence strategies provided the primary structure for the gut microbiome, no such patterns were observed within the oral microbiome. These differential responses to environmental change (diet, hygiene, etc.) are particularly relevant as we seek to characterize the ancestral state of the human microbiome, and explore long term host-microbiome co-evolutionary patterns.

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### Get rid of the ugly one: congenital deformations and early childhood pathologies in the female monastic population in the Iberian Peninsula

NATAŠA ŠARKIĆ<sup>1</sup>, ROSA DINARÈS<sup>2</sup>, LUCÍA MUÑOZ<sup>1</sup> and JESÚS HERRERÍN<sup>1</sup>

<sup>1</sup>Biology, Universidad Autónoma de Madrid, <sup>2</sup>Radiodiagnóstico, Hospital Universitari General de Catalunya

During the Middle Ages and Early Modern times female monasteries had a very important role in society as centers of spirituality and education, and they often provided shelter, food and medical care for beggars, the sick and orphans. But the life of nuns in the cloister was never very easy, and besides total isolation those women had to endure hard physical labor, fasting and abstinence. But was that their own choice or were they forced to do it?

Analyzing skeletal remains of 250 nuns from three female monasteries: two from Spain (16<sup>th</sup>–17<sup>th</sup> and 19<sup>th</sup> century) and one from Portugal (12<sup>th</sup>–16<sup>th</sup> century), it was noted that the frequency of congenital deformation and early childhood pathologies – various traumas, rickets, scoliosis, chronic diseases etc. – that could affect their health, appearance or mobility was high. Hypothesizing that this would influence the possibility of getting married and/or having children and they would therefore be obliged to go to monastery, we performed a detailed macroscopic and radiographic analysis of those individuals. We also analyzed three female secular populations from the same regions and same chronologies in order to make a comparison. The results confirmed our assumption that the frequency of women with congenital deformations and chronic diseases was higher in the monastic population.

No doubt many women accepted monastic life willingly, but for some of them who, due to their health status, were considered ugly or not healthy maybe life in the monastery was not really a choice but the only possibility.

### Early Life Influences on Dual-Hormone Output in Fathers When Playing With Their Children

MALLIKA S. SARMA<sup>1</sup>, SONNY AGUSTIN BECHAYDA<sup>2</sup> and LEE T. GETTLER<sup>1,3</sup>

<sup>1</sup>Department of Anthropology, University of Notre Dame, <sup>2</sup>USC-Office of Population Studies Foundation, University of San Carlos, <sup>3</sup>The Eck Institute for Global Health, University of Notre Dame

Primate fathers who help care for young often experience physiological changes when transitioning to parenthood. Both human and non-human primate fathers also show

acute changes in hormones such as testosterone and cortisol when interacting with their young. Growing evidence suggests that social experience during early life and young adulthood influence the development of the hypothalamic-pituitary-adrenal (HPA) and hypothalamic-pituitary-gonadal (HPG) axes, though this perspective has been less applied to profiles of cortisol, testosterone, and their joint effects in parenting contexts. Specifically, the dual-hormone hypothesis (DHH) suggests that these hormones may work in conjunction to regulate dominance. However, little research has been done on the DHH in non-competitive/non-hierarchical contexts or the specific direction of the testosterone-cortisol regulation. Here, we tested to see if early life experiences or young adulthood behaviors (pre-parenthood) influenced the relationship between cortisol and testosterone when men later played with their children. Using MANOVA, we found that age at sexual debut predicts the joint change in both testosterone and cortisol, where the older the individual is at the first experience of sexual intercourse, the greater the joint decrease in testosterone and cortisol ( $p < 0.05$ ). Using path analysis, we found that experiencing early life stress predicts change in testosterone when moderated by baseline cortisol ( $p < 0.05$ ). This suggests earlier social experience may influence the development of the HPA and HPG systems as well as the co-regulation of hormone output with important implications for how earlier life experiences shape the physiology and behavior of fathers as they engage in parenting.

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### Parallel tracks: Cross-fertilization in studies of mortality and fertility throughout human history

LISA SATTENSPIEL

Anthropology, University of Missouri

Some paths through an academic's life are unidirectional and relatively straight; others meander, even reversing direction at times. The path taken by James W. Wood is well characterized by the meandering stream, although it clearly has had direction and purpose and has always been focused on central issues in anthropological demography. My own path through academia has also meandered, but it has consistently paralleled and criss-crossed Wood's path, with abundant opportunities for cross-fertilization of ideas. This presentation highlights the most important points of intersection and illustrates the nature of professional interactions and how ideas and research questions can benefit from

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the work of others. Examples from my research, including mathematical and computer simulation models of infectious diseases, archival research and modeling of infectious disease mortality in early 20<sup>th</sup> century Newfoundland and Labrador, and critical assessments of paleodemographic assumptions will be described in relation to Wood's models of human reproductive history, his and colleagues' work on the Black Plague in 14<sup>th</sup> century Europe and the demography of the Orkney Islands, and his and colleagues' examination of the osteological paradox.

### Measures of Evolvability in Human Body Proportions across Latitude

KRISTEN R. R. SAVELL and BENJAMIN M. AUERBACH

Department of Anthropology, University of Tennessee Knoxville

Recent work by Savell et al. (2016. *PNAS* 113:9498-9503) indicates that the response of human body proportions to evolutionary forces across ecogeographic regions is strongly influenced by the pattern of covariation between traits (limb lengths, femoral head size, and body breadth). Results also compliment a growing body of work suggesting that the ecogeographic distribution of body proportions is driven by a combination of natural selection and population structure. In this project, we further explore the evolution of human body proportions across ecogeographic regions by calculating several measures of evolvability.

In Savell et al. (2016), we estimated the variation-covariation matrices and selection gradients required to evolve one group into another for pairs of populations across major climate regions. These estimates were used in this project to calculate the evolvability, respondability, conditional evolvability and autonomy for each pair of inter-regional crosses (following Hansen and Houle). These calculations measure different aspects of the ability of traits to respond to directional selection. We found evolvability and respondability increase in heterogeneity and magnitude at higher latitudes, while autonomy and conditional evolvability decrease at higher latitudes. Together with previous findings, this provides evidence that selective pressures have acted on body proportions at higher latitudes and that the pattern of covariation between limb length, femoral head size, and body breadth allows for high respondability to that pressure. The conditional evolvability and autonomy results also suggest that constraint in evolutionary response between traits may be stronger when traits are under selective pressure, such as at higher latitudes.

### Biological continuity over the transition to food production in Eastern Africa: human dental evidence from early pastoralists

ELIZABETH SAWCHUK

Anthropology, University of Toronto

The spread of herding into Eastern Africa is poorly understood; whether it involved migration, diffusion, or a mix of mechanisms is still debated. Domesticated animals first appear in the Turkana Basin ~5000BP, coinciding with construction of megalithic "pillar sites" with human burials. Goat remains and zoomorphic artifacts suggest the architects were pastoralists, while ceramic and lithic technology deviates substantially from prior Later Stone Age (LSA) fisher-hunter-gatherers. Archaeologists have therefore proposed that these herders migrated in from desiccating areas of the Sahara, Sahel, or Ethiopian Rift. Human remains from pillar sites present an opportunity to assess biological affinity through dental morphology. To test the migration hypothesis, 37 crown, root, and intraoral osseous non-metric traits were compared between the pillar sites (n=25 permanent dentitions) and archaeological skeletons from Holocene LSA (n=40), early herder (n=53), and Pastoral Neolithic (PN) (n=91) sites from Kenya and Tanzania. Additional comparisons were made with Historic Turkana peoples, plus pooled dental trait frequencies from North, sub-Saharan, and Southern Africa. Biological distances generated using mean measure of divergence and visualized with multi-dimensional scaling reveal no significant phenetic differences between the pillar sites and LSA and PN samples, indicating biological continuity across this transition. If early herding involved in-migration, substantial gene flow occurred between indigenous foragers and incoming herders. These interactions appear to have influenced development of herding-intensive PN cultures later on in the south-central Rift Valley. Conversely, significant differences between the Eastern African archaeological samples and contemporary groups contribute to our broader understanding of African dental diversity through time.

### Engaging in Combat: Interpersonal Violence in the Ancient Greek Colony, Himera

CAITLIN SAWYER<sup>1</sup>, BRITNEY KYLE<sup>2</sup>, NORMA LONOCE<sup>3</sup>, STEFANO VASSALLO<sup>4</sup>, PIER F. FABBRIO<sup>3</sup> and LAURIE J. REITSEMA<sup>5</sup>

<sup>1</sup>Anthropology, University of Central Florida,

<sup>2</sup>Anthropology, University of Northern Colorado,

<sup>3</sup>Cultural Heritage, Università del Salento,

<sup>4</sup>Soprintendenza BB.CC.AA. di Palermo, Palermo,

<sup>5</sup>Anthropology, University of Georgia

We investigate skeletal trauma among individuals in mass graves killed at the Greek colony of Himera during two ancient battles (480 BCE and 409 BCE). In opposition to continued Greek expansion, Carthaginian leaders and neighboring Punic

allies laid siege to Himera. According to historical documents, the 480 BCE battle comprised male Greek soldiers and foreign mercenaries, culminating in a Greek victory. The 409 BCE battle, in contrast, involved untrained civilians from Himera and resulted in the fall of the city. Our two major objectives are (1) determine if differences exist in the sex and age profiles of the mass graves from the two battles, and (2) test if individuals who died in the two battles experienced different incidences and/or types of trauma. Sex and age distributions were compared between the two battles, with more variation expected in the later battle. Type, severity, and timing of trauma were recorded based on The Global History of Health Data Collection Codebook.

All skeletons from both battles were identified as male. Young individuals were more numerous in the first battle, and greater variation in age was observed in the second battle, but these differences were not statistically significant (Kolmogorov-Smirnov  $p > 0.05$ ). Interestingly, no trauma was observed in the 409 BCE battle. More antemortem and perimortem trauma in the first battle suggests that the trained Greek soldiers and mercenaries in the first battle sustained more physical trauma during the battle and in previous battles than the potential civilians who died in the second battle.

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### Objectively Measured Physical Activity among the Pokot Agro-Pastoralists of Kenya

M. KATHERINE SAYRE<sup>1</sup>, DAVID A. RAICHLEN<sup>1</sup>, EMMA N. BUNKLEY<sup>1</sup>, DOREEN A. ODERA<sup>2</sup>, CASSIDY A. REEVES<sup>3</sup> and IVY L. PIKE<sup>1</sup>

<sup>1</sup>School of Anthropology, University of Arizona,

<sup>2</sup>Institute of Anthropology, Gender, and African Studies, University of Nairobi,

<sup>3</sup>School of Anthropology, University of Colorado Boulder

Levels and patterns of physical activity impact individual health, fitness, and longevity. Individuals living in industrialized societies are often characterized as more sedentary than those who live in smaller scale societies, and this inactivity is generally linked with increased incidence of chronic disease. However, less empirical data exists regarding levels and patterns of physical activity (PA) among smaller scale societies. The goal of this study is to characterize levels of MVPA (moderate-to-vigorous physical activity) among the Pokot agro-pastoralists of rural Kenya. MVPA was measured in 45 participants ranging in age from 14 to 78 using Actigraph wrist-worn accelerometers. Wear-time spanned 24 hours to 72 hours, with a modal wear time of 48 hours. Average daily MVPA was 178.63 minutes ( $\pm 82.15$  minutes) for all participants. MVPA in men (n=22)

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was 210.44 minutes ( $\pm 63.52$  minutes), and MVPA for women ( $n=23$ ) was 148.20 minutes ( $\pm 87.56$  minutes), though the difference between men and women was not significant ( $p=0.07$ ). These values far exceed US governmental guidelines of 150 minutes of MVPA *per week*. The Pokot show a significant ( $p=0.001$ ) age-related decline in MVPA across the lifespan, with adolescents displaying the highest levels of MVPA for both men and women. Levels of PA among the Pokot will be discussed in a comparative context with PA levels recorded for societies who engage in other subsistence strategies, including foragers, other pastoralists, and individuals living in industrialized societies. Implications for the intersection between activity levels, subsistence strategies, and health will also be discussed.

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### Female Strategies during Intergroup Aggression among Tufted Capuchin Monkeys (*Sapajus nigritus*)

CLARA J. SCARRY

Department of Anthropology, Miami University, Department of Anthropology, University of Texas at Austin

In many primate species, female participation in intergroup aggression is limited, even if between-group contest competition for food is strong, due to the potential costs of sexual coercion and infanticide by extragroup males. Among tufted capuchin monkeys, however, female participation in aggressive chases or displays during encounters is common, suggesting that females are not simply free-riding on the aggressive behavior of resident males. Here I examine the factors influencing individual participation by females during aggressive intergroup encounters among tufted capuchin monkeys (*Sapajus nigritus*) in Iguazú National Park, Argentina. I conducted all-day follows of four habituated groups, recording individual participation and leadership *ad libitum* during encounters ( $n = 88$ ). Although, females were more likely to participate during encounters in which their group had a competitive advantage (i.e., more males), among female participants, leadership during intergroup aggression was more likely when the group was at a competitive disadvantage (GLMM:  $p < 0.05$ ). Neither dominance rank nor the number of matrilineal kin present influenced individual behavior during intergroup encounters. Instead, females appeared to adjust their behavior in accordance with their reproductive state; females with young dependent infants were more likely to lead during aggressive intergroup encounters (GLMM:  $p < 0.05$ ). This pattern of more active nature of participation by females with infants suggests that

energetic costs rather than risks from intersexual aggression determine female behavior.

### Stressed Before Sacrifice? Reconstructing Psychosocial Stress from Archaeological Hair at Chotuna-Chornancap, Peru

BENJAMIN J. SCHAEFER<sup>1</sup>, BETHANY L. TURNER<sup>1</sup> and HAAGEN D. KLAUS<sup>2</sup>

<sup>1</sup>Anthropology, Georgia State University, <sup>2</sup>Sociology and Anthropology, George Mason University

The Inka Empire of 15<sup>th</sup>-century Andean South America practiced flexible forms of statecraft that affected their subject populations in varied ways. Understanding the lived experiences of different Inka subjects therefore requires nuanced bioarchaeological approaches. This study aims to interpret psychosocial stress through assays of cortisol in archaeological hair from sacrificed individuals ( $n=19$ ) recovered in the Huaca de los Sacrificios at the Chotuna-Chornancap Archaeological complex. This site is located in the Lambayeque region on the north coast of Peru, and was used as a ritual and ceremonial complex by both the Inka and earlier Chimú states; the remains analyzed here are associated with the Inka period (AD 1450-1532). Previous osteological and multi-isotopic analyses indicate that the sacrificed individuals were local to the north coast, and had no change in diet prior to death; this implies traditional north-coast sacrificial practices rather than those in the Inka heartland. Utilizing enzyme-linked immunosorbent assay (ELISA) to obtain both overall and segmented cortisol levels, this study examines spikes in cortisol and analyzes these data along with existing osteological and isotopic data from this study sample. These cortisol levels are also compared to published levels in living participants, to better reconstruct and infer overall stress levels in these sacrificed individuals. Preliminary results suggest elevated cortisol levels in several individuals that may indicate high levels of psychosocial stress, suggesting that these sacrificed individuals were marginalized in the surrounding community. However, this analysis also considers potential confounders including pregnancy/parturition and childhood developmental stages among young adult females and subadults.

### Teaching Critical Thinking Skills through the Scientific Method: A Comparison of Different Levels of Active Engagement

MELISSA S. SCHAEFER

Anthropology, Salt Lake Community College

Research reports that 98% of colleges and universities identify critical thinking/analytic reasoning skills as a learning outcome. Pedagogy on teaching critical thinking asserts that critical thinking skills are not learned passively. The current research compared different levels of

active engagement with the scientific method (a form of critical thinking) in passively teaching critical thinking skills, specifically critical evaluation of data. The ability to critically evaluate data was compared between four groups of students divided by the level of active engagement with the scientific method. 'Passive' group had no engagement with the scientific method, 'Online' group participated in an online activity (low engagement), 'In-Class' group participated in an in-class activity (medium engagement) and 'In-Field' group participated in a field school (high engagement). Each group identified a hypothesis and data and completed a writing assignment with instructions to critically evaluate the data; no group received direct instruction on how to do so. The assignments were assessed for critical evaluation of the data using a modified 4-point AAC&U VALUE Rubric (competent response = 3). The sample size was 15 per group. Rubric scores were compared using Kruskal-Wallis (Rank Sum) Test. Results found significant difference between no/low engagement groups (median score of 1 for both groups) and medium/high engagement (median scores of 3 and 4 respectively) groups ( $\chi^2(3) = 38.2172, p < 0.001$ ). These results suggest that some critical thinking skills can be taught without direct instruction and that this ability improves with increasing levels of active learning.

### Kin structure of the Amarna South Tombs Cemetery

WILLIAM C. SCHAEFFER<sup>1</sup>, CHRISTOPHER M. STOJANOWSKI<sup>1</sup>, JEROME C. ROSE<sup>2</sup> and JANE E. BUIKSTRA<sup>1</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Anthropology, University of Arkansas

The primary objective of this study is to investigate whether biological kinship structured the Amarna South Tombs Cemetery (c. 1352–1336 BCE). Amarna is one of a few New Kingdom settlements that present a unique glimpse of ancient Egyptian city life. The Amarna city plan shows the estates of high officials, their families, as well as servants and kin situated in nucleated clusters throughout different neighborhoods of the city. We ask here if the same pattern of kin group nucleation is also present in the cemetery located in the dry riverbed adjacent to the South Tombs. Euclidean grave shaft distances were compared with Mahalanobis  $D^2$  distances from 15 dental cervical measurements for 95 individuals. Spatial autocorrelation was assessed using Mantel tests. Results of this study suggest robust patterns in cemetery structure. Females have a strong correlation ( $p < 0.05$ ) between spatial and biological distances within the cemetery as a whole. This structure may have been influenced by post-marital residence rules. Cemetery samples in closer proximity to the South Tombs

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show strong spatial autocorrelation ( $p < 0.05$ ) for males, females, and subadults (10–14 and 15–19 years), but this structure disintegrates as one moves further away from the cliffs of the South Tombs. These patterns apparently mimic the clustering of families around high officials as seen in the residential parts of the city itself, reinforcing the relationship among servant and statesman that existed in ancient Egyptian life and persisting into the afterlife.

*This study was supported by the King Fahd Center for Middle East Studies at the University of Arkansas.*

### Comparison of southwestern US Hispanic populations to Mexican Hispanic populations using immunoglobulin haplotypes

MOSES S. SCHANFIELD

Forensic Science, The George Washington University

The heavy chain immunoglobulin (IGH) haplotypes were the earliest ancestry informative markers (AIMs), the Kappa light chain (KM) haplotypes are less so. Historically in the Southwestern US, individuals identified as Hispanic have originated in Mexico. The question arises as to variation among the SW US Hispanics and their relationship to Mexican populations. To investigate this data on IGH and KM haplotypes were used.

IGH and KM haplotypes from 1,265 HHANES samples from 17 locations (SW US) and 1,400 Parentage samples, were compared to 1,517 Mexican Indians (7 tribes) and 1,408 Mexican urban samples (9 locations) using  $F_{wr}$ ,  $F_{rt}$  and  $F_{st}$  statistics.

No significant variation was found among the 17 US samples divided by state for immunoglobulin haplotypes. There was highly significant variation between Mexican tribal and urban samples ( $F_{rt}=0.0321$ ,  $\chi^2=8.254$ ,  $p=0.004$ ;  $F_{st}=0.056$ ,  $\chi^2=8.254$ ,  $p=0.0001$ ) for IGH haplotypes, while only total  $F_{st}$  was significant for KM haplotypes ( $F_{st}=0.037$ ,  $\chi^2=9.576$ ,  $p=0.0019$ ) after Bonferroni correction. Comparing US to Mexican (tribal and urban) indicated significant variation ( $F_{rt}=0.046$ ,  $\chi^2=8.449$ ,  $p=0.0036$ ;  $F_{st}=0.064$ ,  $\chi^2=11.589$ ,  $p=0.0006$ ) for IGH haplotypes after Bonferroni correction. The primary difference was the amount of European admixture, increasing from Mexican Indians, Urbans and US populations (0.057, 0.246, 0.375,  $F_{st}=0.098$ ,  $\chi^2=19.340$ ,  $p=0.000$ ), with African haplotypes also increasing (0.014, 0.035 and 0.045), but not significantly.

These results indicate that SW US Hispanics are a relatively homogeneous group. Representing immigrants with more European and African gene flow than populations resident in Mexico. However, individual SW US Hispanics have wide variation in individual admixture.

### Effects of Mounting Adhesives and Solvent Treatments on Sequential Sectioning of Dentine Samples for Stable Isotope Analysis (C, N)

IAN SCHARLOTTA

Laboratoire méditerranéen de préhistoire Europe Afrique, Aix-Marseille Université

LAMPEA is pursuing micro-sampling strategies in biogeochemical research with the explicit purpose of testing hypotheses regarding hunter-gatherer sociopolitical and economic strategies in Cis-Baikal, Siberia. Differences between micro-regions and chronological units have been apparent for many years; however, the means by which specific hypotheses regarding the underlying structures responsible for these differences had not yet been developed and/or refined to the temporal scale necessary to examine hunter-gatherer groups with sufficient resolution. Bulk data for Sr, C, and N, have indicated both the presence of variability and the need for further refinement prior to their use in support of clear behavioral inferences. Preservation conditions vary greatly between contemporary cemeteries. As a result standard demineralization and collagen extraction procedures are likely to yield varied results.

Prior to extensive sampling of human dentine, experimental laboratory methods were modified to include steps for the possible use of two adhesives as a supporting medium during cutting. The two adhesives have low melting points ( $<80^\circ\text{C}$ ) and should be fully soluble in mild solvents (warm water, acetone). The adhesives are known to contain carbon and could potentially contaminate samples, but are easier to handle than dental plaster for mounting and micro-sampling. The low temperature flow point suggests limited intrusion of micro-pore spaces of teeth and bones. Pig and cow teeth were used in an experimental comparison of different combinations of adhesive and solvent. Faunal materials were employed to cut into subsections large enough to produce adequate collagen yields along comparable portions of the dentine.

*A\*Midex Project: Middle Holocene hunter-gatherers in Cis-Baikal, Siberia: dietary history via stable isotope analysis and micro-sampling of human molars*

### The evolution of the human hippocampus and neuroplasticity

BRIAN M. SCHILDER, BRENDA J. BRADLEY and CHET C. SHERWOOD

Center for Advanced Study of Human Paleobiology, The George Washington University

While the hippocampus is central to the storage and retrieval of information in long-term memory in all mammals, only humans are known to possess episodic memory, the capacity to recall specific experiences. However little is known concerning how the human hippocampus

differs from that of nonhuman primates (NHPs). Using previously published whole-transcriptome gene expression data (Konopka et al. 2012) we investigated whether several candidate genes with known roles in plasticity and adult neurogenesis (doublecortin [DCX], brain-derived neurotrophic factor [BDNF], glial fibrillary acidic protein [GFAP], and ephrin-B1 [EPHB1]) are differentially expressed in human hippocampus relative to those of NHPs. Both DCX and EFNB1 showed significantly lower expression in human hippocampus compared to chimpanzees and macaques ( $p < 0.05$ ).

To test whether these expression differences could be related to gene-sequence differences we next analyzed aligned orthologous sequences of 12 primates and 3 non-primates using five different substitution models of positive selection detection using the HyPhy packages on the Datamonkey server. Of these genes/sites only DCX (S36N in the *Pan troglodytes* branch) and GFAP (G149A in the branch leading to the *Homo-Pan-Gorilla* clade, and G149T in the *Tupaia chinensis* branch) showed any evidence of positive selection ( $p < 0.05$ ). However, when the likely effects of these substitutions were assessed using PolyPhen2 and SNAP2 they were predicted to have no functional effect on the protein. Future analyses will explore additional genes important for hippocampal function. These results will provide further insight into the evolution of the human hippocampus and memory.

### Statistical shape analysis using statistical shape models - comparing surface to outline data in the human zygomatic structure

STEFAN SCHLAGER and ALEXANDRA RÜDELL  
Biological Anthropology, Albert-Ludwigs University

Morphometric analysis of structures lacking well defined landmarks is a challenging task. We are proposing a method based on a surface registration procedure that incorporates a statistical shape modeling approach. Hereby, only few reliable landmarks are needed to provide prior information and to guide the registration process, establishing reliable point-to-point correspondences. We applied this method to analyze the human zygomatic structure, consisting of the zygomatic bone and the zygomatic process of the temporal bone, which is an essential part of the masticatory apparatus.

Following the registration process, a dense set of 1480 pseudo-landmarks was sampled from the surface of the pooled mean shape and three curves were digitized manually along the outlines of the zygomatic bone. Both sets of pseudo-landmarks were automatically transferred to all specimens, exploiting the consistent mesh topology throughout the registered surfaces. Apart from validating the registration method,

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our goal was to assess the predictive value of the outlines vs. the complete surface shape of the zygomatic structure in a sample of 98 Chinese (50', 48') and 96 German (49', 47') individuals. Using the entire surface data increased prediction accuracy significantly, especially for sexing, where including the entire surface shape increases the cross-validated accuracy from 77.8% for the curve data to 89.2%. Using a method that reliably establishes point-to-point correspondences allows to increase the sensitivity of the statistical analysis even for structures where no or very few anatomical landmarks can be placed.

### Tree preference and coexistence of white-faced capuchins and mantled howler monkeys in a Costa Rican forest fragment

RENATE M. SCHLAHT and AMY L. SCHREIER  
Department of Biology, Regis University

Deforestation is one of the biggest threats to global biodiversity, fragmenting habitat and altering the availability of resources in remaining forests. This results in smaller and less productive patches of forest compromised by edge effects. With fewer resources available, it is more difficult for species to live together as they compete for food and habitat. To understand primate coexistence in these circumstances, we analyzed tree preference in white-faced capuchins (*Cebus capucinus*) and mantled howler monkeys (*Alouatta palliata*) sharing a fragmented forest habitat at La Suerte Biological Research Station in Costa Rica. Because of capuchins' more varied activity budget and energy-rich diet, we hypothesized that they would use more total trees as well as more tree species for resting and feeding than would howler monkeys. In May-June 2015 and June-July 2016 we collected behavioral data and identified the trees (to the species level when possible) used by these two species. We also recorded the forest level of each tree and measured DBH. As predicted, findings show greater tree and tree species use by capuchins, as well as a tendency for capuchins to use smaller and canopy level trees. Capuchins used an average of 10.9 trees per hour for feeding and 8.4 trees per hour for resting while howler monkeys used an average of 3.2 and 2.4 trees per hour for feeding and resting, respectively. These results show varying use of the same habitat by two sympatric primates, suggesting natural adaptations that allow for coexistence in an anthropogenically altered forest environment.

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### Neandertal Dental Microwear Texture Analysis from l'Hortus: A Bioarchaeological Perspective

JESSICA L. DROKE<sup>1</sup>, FRANK L'ENGLE WILLIAMS<sup>2</sup>, CHRISTOPHER W. SCHMIDT<sup>1</sup> and JOHN C. WILLMAN<sup>3</sup>

<sup>1</sup>Anthropology, University of Indianapolis,  
<sup>2</sup>Anthropology, Georgia State University,  
<sup>3</sup>Anthropology, Washington University

Dental microwear texture analysis (DMTA) is a means of determining ancient diets that uses a white light confocal profiler to examine phase II wear facets on molar occlusal surfaces. Here it is used to conduct a population-based, bioarchaeological study of l'Hortus, a Neandertal mortuary site dating to MIS-3 (60-30kya) from southern France (MNI = 20). Five adults and one subadult had teeth suitable for DMTA. They were compared to single individuals from Spy, Engis, Kůlna, Švédův stůl, Arcy-sur-Cure, La Quina, Montmaurin, Pech de l'Azé, Rabat, Kebara, and 2 individuals from Tabun. All are from MIS-6 (n = 1), MIS-5 (n = 3), MIS-4 (n = 4) and MIS-3 (n = 4). Molar replicas were analyzed following standard procedures. Four variables, complexity (Asfc), anisotropy (epLsar), textural fill volume (Tfv), and scale of maximum complexity (Smc) were calculated using scale-sensitive fractal analysis software (Sfrax<sup>®</sup> and Toothfrax<sup>®</sup>). Results indicate that the l'Hortus Neandertals had a mean complexity value of 1.30; the within-group range of variation was modest, including the child. Anisotropy at l'Hortus was high (0.0035) and similar to Kebara and Tabun. Smc and Tfv values are like the other Neandertals in the study (0.471 and 40466, respectively). Overall the DMTA indicates a diet consistent with foragers who consumed tough or homogenous foods and some hard foods. Overall, it bears similarities to Neandertals from the Mediterranean area.

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### Queer developments: LGBTQIA perspectives on ontogeny, growth and development, and ranges of variation in human and nonhuman primates

CHRISTOPHER A. SCHMITT<sup>1</sup>, CLAUDIA M. ASTORINO<sup>2,3</sup> and STEPHANIE L. MEREDITH<sup>4</sup>

<sup>1</sup>Department of Anthropology, Boston University,  
<sup>2</sup>Department of Anthropology, The Graduate School and University Center, The City University of New York, <sup>3</sup>New York Consortium in Evolutionary Primatology, <sup>4</sup>Department of Sociology and Anthropology, University of La Verne

Most people's physical and behavioral phenotypes fit comfortably within societal norms absent special thought or effort. Being LGBTQIA is, in many ways, a persistent act of self-awareness and revision in relation to those norms. Our

particular positionalities outside societal norms during development fundamentally shaped our interests in and academic approaches to human and non-human primate growth, development, and variation. CAS's constant process of interrogating whether, how, and why he came to live outside accepted male gender norms as a child eventually translated into a deep curiosity about and multifaceted approach to understanding primate development. CMA, an intersex person – someone born with a combination of traits considered traditionally male, female, and/or atypical for either in the same body – knew she was different from a young age, sparking her interest in ranges of biological variation and the causes of such diversity. SLM's gender atypicality drove her curiosity about the consistent canalization of typicality itself—why and how do so many individuals become gender-typical? Our lack of intuitive understanding of the norm generates fewer (or different) implicit assumptions about the norm, constant critique of biological categorization that does not fully describe the data, and appreciation of the need to understand all aspects of biological variation. Through our experiential knowledge of the inadequacy of sex and gender categories, the interactive effects of intrinsic and extrinsic forces on developmental outcomes, and the production of "normality" as an active process requiring scrutiny, our otherness has shaped the way we interrogate the world and practice science.

### Is all Quadrupedalism the Same? Form-function Relationships in Behaviorally Flexible Primates

DANIEL SCHMITT<sup>1</sup> and MICHAEL C. GRANATOSKY<sup>2</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University,  
<sup>2</sup>Department of Organismal Biology and Anatomy, University of Chicago

To facilitate functional comparisons anthropologists often choose to categorize primates in discrete locomotor groups despite the fact that primates can adopt multiple locomotor modes and often have anatomies that represent a compromise between multiple functional demands. Quadrupedal walking gaits are common among primates including in species that are anatomically specialized for other forms of locomotion. This provides an ideal opportunity to explore trade-offs and compromise in behavioral and morphological adaptation. In this study, we explore these potential trade-offs in a broad phylogenetic and behavioral range of primate species. Kinematic and spatiotemporal gait variables (22 variables analyzed) collected from 15 species of primate (N=546 strides) were evaluated using principal component analysis (PCA), and from the three-dimensional point clusters we tested whether: (1) quadrupedal primates will group together regardless of taxonomic affiliation; and (2) species with compromise morphologies reflecting varied locomotor demands will

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occupy different regions of quadrupedal locomotor space than primarily quadrupedal species. PCA, primarily weighted by contact time and midstance elbow and knee flexion, successfully grouped primates functionally. Primarily suspensory and leaping species demonstrate the most distinct patterns of quadrupedal movement that appear to equalize effective forelimb and hindlimb limb length. Additionally, suspensory species appear to adopt mechanisms that may moderate compressive forces on forelimb joints. The results demonstrate remarkable variation in quadrupedal mechanics, provide insight into strategies primates adopt to achieve quadrupedal gaits despite anatomical specializations for other forms of locomotion, and illuminate ways in which animals might transition between modes of locomotion over the course of their evolution.

### Reduced Immune Investment with Energy Stress: Evidence from a Mouse Model

ALAINA L. SCHNEIDER<sup>1</sup>, NESHA S. BURGHARDT<sup>2</sup> and HERMAN PONTZER<sup>1,3</sup>

<sup>1</sup>Department of Anthropology, Hunter College, New York, NY, USA, <sup>2</sup>Department of Psychology, Hunter College, New York, NY, USA, <sup>3</sup>New York Consortium of Evolutionary Primatology, New York, NY, USA

During periods of energy stress, organisms must allocate limited resources to some tasks at the expense of others. Prioritization of energy among competing organ systems during growth in humans and other mammals is understudied. Here, we examine the effects of food restriction and physical activity on organ growth in mice. We placed 32 adolescent female mice (129/SvEv) into four conditions ( $n=8$  each): Activity Based Anorexia, ABA (high activity, food restriction); Food Restricted, FR (low activity, food restriction); Wheel Control, WC (high activity, high food availability); and Home Control, HC (low activity, high food availability). After 10 days in each condition, mice were euthanized and their organs weighed. Organ weights (heart, brain, liver, kidney, and spleen), femur lengths, and body masses were compared across conditions. Food restricted mice (ABA and FR) exhibited a reduction in body mass and commensurate reductions in liver, heart, and kidney mass, relative to non-food restricted counterparts (HC and WH). Spleen size was reduced more than other organs, indicating resource allocation away from immune function and prioritization of other systems. We examine these results in light of evidence that the immune response in humans is of high metabolic cost. We discuss the implications of our results for understanding the immune system's function in the evolved metabolic response to energy stress in humans.

### Modern Human Variation in Brain Size: Implications for the Dmanisi Hominins and other Fossil Taxa

P. THOMAS SCHOENEMANN<sup>1,2</sup> and RALPH L. HOLLOWAY<sup>3</sup>

<sup>1</sup>Anthropology, Indiana University, <sup>2</sup>Paleoneurology, Stone Age Institute, <sup>3</sup>Anthropology, Columbia University

How much variation in a particular biological characteristic one can expect within a species is an important consideration when trying to determine whether sets of fossil specimens could conceivably be members of the same species. Some have suggested that the range of morphological variation among the Dmanisi hominins indicates they are likely not members of the same species (e.g., Schwartz et al. 2014). In response, Zollikofer et al. (2014) argue the Dmanisi hominins are not too variable to preclude their being members of the same species. One character not specifically discussed by Zollikofer et al. (2014) is brain size. The Dmanisi hominins range from 546 cc to 775 cc (amounting to 35.5% of their mean cc). Is this unusually large with respect to known within-species ranges of variation? Data on brain size variation within modern humans, from an MRI study of 36 same-sex female sibling pairs (72 individuals in total) shows that the largest *within-family* sib difference (234.9 cc) amounted to 20% of their mean cc. The largest *between-individual* (non-sib) difference amounted to 34.6% of the mean cc - very close to that found among the Dmanisi hominins. Given this sample only included females, and given the sex difference in brain size (~10%), these estimates can be considered lower bounds of the likely range of within-species variation in brain size within humans. Thus, the range of variation in cranial capacity seen among the Dmanisi hominins is not strong evidence that they are members of different species

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### Stable Isotope Ratios ( $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ) of Hair Indicate Habitat Ecology and Diet at Two Chimpanzee Study Sites

MARGARET J. SCHOENINGER, CORINNA A. MOST, JIM J. MOORE and ANDREW D. SOMERVILLE  
Anthropology, University of California, San Diego

Both diet and environment influence the stable isotope ratios of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) in hair keratin. Here we present the results of stable isotope analyses of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of chimpanzee (*Pan troglodytes*) hairs from two sites in Tanzania, Ugalla and Gombe. Ugalla is miombo (savanna) woodland with  $\text{C}_4$  grass groundcover and small patches of forest, while Gombe is a more forested area that ranges from grassland to tropical rainforest. Samples from Gombe belong to chimpanzees from two groups,

Kasekela and Mitumba, which inhabit separate areas of the park. Hairs were collected from night nests between 1989 and 2007.

Within Gombe, Mitumba individuals, who range in a more forested region, exhibit lower  $\delta^{13}\text{C}$  values and significantly higher  $\delta^{15}\text{N}$  values ( $p=0.005$ ) in comparison to Kasekela individuals, who range in a more open region, suggesting dietary and/or environmental differences within Gombe. Differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values between Gombe and Ugalla are both significant ( $p<0.001$ ), with Ugalla chimpanzees exhibiting higher  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values relative to Gombe. These follow expectations based on studies of animal proxies, where higher  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values occur in regions of lower precipitation. When compared to other sites the results confirm that  $\delta^{13}\text{C}$  values are mostly influenced by environmental factors in chimpanzees. Ugalla and Gombe specimens, however, exhibit lower than expected  $\delta^{15}\text{N}$  values based on precipitation levels when compared with other sites, suggesting that additional factors, such as dietary selectivity, must be considered when interpreting  $\delta^{15}\text{N}$  values in chimpanzees.

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### Meat-eating in hamadryas baboons: temporal patterns of meat consumption and doum palm fruit availability

AMY L. SCHREIER<sup>1</sup>, RENATE M. SCHLAHT<sup>1</sup> and LARISSA SWEDELL<sup>2,3,4</sup>

<sup>1</sup>Department of Biology, Regis University, <sup>2</sup>Department of Anthropology, Queens College, City University of New York, <sup>3</sup>New York Consortium in Evolutionary Primatology, NYCEP, <sup>4</sup>Department of Archaeology, University of Cape Town

Increasingly, primate species have been observed hunting and consuming meat. Meat-eating may provide them with important nutrients that they cannot obtain elsewhere in their diet. Seasonal variation in plant food availability has been suggested to motivate dietary flexibility in a range of species and thus primates may consume more meat when preferred plant resources are unavailable. In this study we investigate the relationship between meat-eating and resource availability in hamadryas baboons (*Papio hamadryas*) at the Filoha site in Awash National Park, Ethiopia. The Filoha baboons rely on doum palm fruit, a high quality resource unavailable elsewhere in hamadryas range, for several months of the year. We predicted that hamadryas baboons at Filoha would consume more meat when doum palm fruit is unavailable. We recorded meat-eating instances and monitored the availability of doum palm fruit from March 2005-February 2006. Consistent with our prediction, the mean daily rate of meat-eating instances when palm fruit was not abundant was 0.124 compared to 0.058 when palm fruit was available. There was no difference, however, in the rate of meat-eating

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between the dry and wet seasons. These results suggest that the baboons use meat as a means to obtain critical nutrients that are unavailable when palm fruit is not in season. Nutritional analyses of doum palm fruit are necessary for more complete understanding of this dietary shift. Overall, our results highlight the dietary importance of doum palm fruit for the *Filoha hamadryas* population.

### An Examination of the Osteological Distribution of Leprosy Lesion Types: Results from a Meta-analysis on the Paleopathological Literature on *Mycobacterium Leprae*

MALLORY A. SCHREIER

Department of Anthropology, Boise State University

Leprosy is an age-old, chronic infectious disease that leaves disfiguring skin lesions and nerve damage. If the disease progresses enough, the development and distribution of osteological lesions, indicative of the type of leprosy and immune status of the infected, might correlate with pathological and cultural variations between geographical regions and time periods.

This study was the first meta-analysis on leprosy's paleopathological history, analyzing 1,645 leprosy cases from 102 sites dating to 3125 BCE to 1905 CE. The literature reported osteological lesion distribution for 93% of the sites. The monikers *facies-leprosa* only, *post-cranial* only, and *both*, acted as epithets to summarize the lesions reported. The distribution of lesions through time was measured by geographical region. Notably, Northern Europe had the largest amount of leprosy lesions ( $n=203$ ), with 66.1% falling under Northern European skeletons from the Middle Ages with both types. A Fisher's exact test determined that only the Asian samples were significant, proposing that Asian lesion proportions varied by time period from both to *facies-leprosa* only to both. No significant differences were found between the proportions of lesions across time for the other three geographical regions.

However, there was a significant relationship between the proportion of lesions per category across all regions and time periods. This suggests that different geographical regions over thousands of years suffered from either tuberculoid or lepromatous leprosy, which affected different parts of the body. Trends in the data suggest variation due to selective mortality factors, physiological stress, and undeveloped osseous lesions.

### The evolution of hominoid cranial diversity: a quantitative genetics approach

LAUREN SCHROEDER and NOREEN VON CRAMON-TAUBADEL

Anthropology, University at Buffalo

Hominoid cranial evolution is characterized by a large amount of phenotypic diversity, yet the cause of this variability has rarely been explored. Previous studies have successfully applied quantitative genetic techniques to investigate the evolutionary processes responsible for the morphological divergence among primate taxa, however, these studies are dependent on the availability of good ancestral models, which is problematic in hominoids where the fossil record is sparse. Here, we use a newly developed method, based on weighted averages calculated from genetic branch lengths and relative morphological differences, to estimate nested hypothetical ancestral forms from extant hominoid taxa. These hypothetical ancestors were used to calculate rates of evolution along each branch of a fully-resolved phylogenetic tree using Lande's generalized genetic distance, which follows a chi-squared distribution under genetic drift. Deviations from this distribution reflect stabilizing or directional selection. Overall, our results show that the evolution of the hominoid cranium was largely characterized by strong stabilizing selection within genera, while genus-level diversification was largely neutral. Only two instances of directional selection were detected; (1) the divergence of *Homo* from its last common ancestor with *Pan*, and (2) the divergence of the lesser and greater apes. In these two cases, selection vectors were reconstructed to identify the specific traits affected by this evolutionary pressure. Selection vectors indicate that the divergence of *Homo* was characterized by selection on basicranial flexion, whereas the divergence of the lesser and greater apes was defined by selection on cranial vault height and anterior vault projection.

### Ancient Egyptian mummy genomes suggest an increase of Sub-Saharan African ancestry in post-Roman periods

VERENA J. SCHUENEMANN<sup>1,2</sup>, ALEXANDER PELTZER<sup>3,4</sup>, WOLFGANG HAAK<sup>1</sup>, STEPHAN SCHIFFELS<sup>4</sup> and JOHANNES KRAUSE<sup>1,4</sup>

<sup>1</sup>Archaeo- and Paleogenetics, Institute for Archaeological Sciences, University of Tuebingen,

<sup>2</sup>Senckenberg Center for Human Evolution and Paleoenvironment, University of Tuebingen,

<sup>3</sup>Integrative Transcriptomics, Center for Bioinformatics, University of Tuebingen, <sup>4</sup>Department for Archaeogenetics, Max Planck Institute for the Science of Human History

Egypt, located on the isthmus of Africa, is an ideal region to study historical population dynamics due to its geographic location and documented interactions with ancient civilizations in Africa, Asia,

and Europe. Particularly, in the first millennium BCE, Egypt endured foreign domination leading to growing numbers of foreigners living within its borders possibly contributing genetically to the local population. However, methodological problems and contamination obstacles have hitherto hampered direct investigations of ancient Egypt's population history using ancient human DNA. Here we present mtDNA and nuclear DNA from mummified humans from Middle Egypt recovered with High-throughput sequencing methods that span around 1,300 years of ancient Egyptian history from the Third Intermediate to the Roman Period. Our analyses reveal that ancient Egyptians shared more ancestry with Near Eastern populations than present-day Egyptians, who admixed with Sub-Saharan populations in more recent times. This analysis establishes ancient Egyptian mummies as a genetic source to study ancient human history and opens the perspective of deciphering Egypt's past at a genome-wide level.

### Dietary abrasiveness and chewing efficiency in chimpanzees

ELLEN SCHULZ-KORNAS<sup>1</sup>, JULIA STUHLTRAEGER<sup>1</sup>, ROMAN WITTIG<sup>2,3</sup> and KORNELIUS KUPCZIK<sup>1</sup>

<sup>1</sup>Max Planck Weizmann Center for Integrative Archaeology and Anthropology, Max Planck Institute for Evolutionary Anthropology, <sup>2</sup>Department of Primatology, Max Planck Institute for Evolutionary Anthropology, <sup>3</sup>Tai Chimpanzee Project

Primate dietary preferences are sex-specific and are subject to seasonal variation. Here we investigate whether such differences are reflected by both tooth wear and chewing efficiency in the western chimpanzee (*Pan troglodytes verus*). While wear is a proxy of dietary abrasiveness, chewing efficiency represented by mean fecal particle size reflects seasonal food availability and properties. We establish to what extent both help to differentiate between the sexes and between the dry and wet seasons. Long-term feeding ecological data (1994-2005) of 17 adult chimpanzees of the Tai National Park (Côte d'Ivoire) are matched to 3D surface texture signatures (ST) measured on cheek teeth (facets 3, 9) of the same individuals after death. Additionally, we combined these two datasets with results of a fecal particle size (FP) analysis of 8 adult chimpanzees from the current Tai population (2014-2015). We found that males consumed more fruits and meat, which corresponded with more heterogeneous STs with higher peaks, deeper furrows and smaller FPs. In contrast, females consumed more dicotyledonous plants and insects, and had more plateaus and smaller peaks on the facets combined with larger FPs. During the dry season, STs were flatter and FPs smaller compared to the wet season. We suggest that dust carried during the dry season by the harmattan wind into the forest removes features on the wear facets leading to the observed

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seasonal differences. Our findings show the great potential for using both STs and FPs to reveal sex-specific dietary preferences within a species and for (palaeo-)habitat reconstructions.

*This research was funded by the Max Planck Society.*

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### Socio-cultural influences on genetic variation in nomadic populations of northern Eurasia

THEODORE G. SCHURR

Anthropology, University Of Pennsylvania

In this paper, I discuss genetic research conducted with populations residing in Central Asia and Siberia, including Turkic, Mongolic and Altaic speaking groups. Our research in this region of the world has revealed distinct patterns of genetic variation based on mtDNA and Y-chromosome data sets. Most of these populations exhibit considerable mtDNA diversity consisting of a mixture of East and West Eurasian lineages. This broad Eurasia maternal gene pool appears to have formed over many thousands of years of population interactions across the steppe. From a Y-chromosome perspective, however, these groups show a more limited range of paternal lineages, with a few haplogroups tending to predominate in many of them. The Y-chromosome data demonstrate genetic influences from both West and East Eurasia, reflecting the entry of steppe peoples into Central Asia several thousand years ago, and also the influence of Turkic and Mongolic groups which expansions across this area. Furthermore, these data reflect the patterns of subsistence and social organization followed by these populations, with patrilineal kin groups shaping the Y-chromosome diversity present in them. I explore the implications of these data for the phylogeography and genetic ancestry of populations in northern Eurasia.

*The work described in this paper was supported by the National Science Foundation, IFOND (Russia), SSHRC (Canada), the University of Pennsylvania, and the University of Pennsylvania Museum of Archeology and Anthropology.*

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### Between Land and Sea – Bioarchaeological Dynamics at Middle Bronze Age Sidon, Lebanon

HOLGER SCHUTKOWSKI and NIVIEN SPEITH

Dept. of Archaeology, Anthropology, and Forensic Science, Bournemouth University

During the Middle Bronze Age (MBA, 2000-1550 BCE), Sidon became established as a thriving urban polity of trade, ritual, and communication. Zooarchaeological, botanical and isotopic analyses indicate a wide variety of foodstuffs used to provide a largely C<sub>3</sub>-based diet of cereal grains and pulses, complemented by domestic livestock as well as offshore and littoral fishing. The society

is distinctly stratified, mortuary evidence attests to elite burials, and gendered division of labour is pronounced. We report here on bioarchaeological investigations encompassing 115 individuals (68 non-adult, 47 adult) to outline patterns of life course and death.

The age profile is characterised by high infant and early childhood mortality (43%) and an overall inconspicuous mortality in adulthood. Male mortality was consistently higher in children between two and six years of age, reflecting a higher risk of susceptibility to disease, while earlier and later stages of childhood showed no significant differences. Both boys and girls were weaned from about the age of one with no obvious sex preference, even though some boys died with marginal nutritional status, suggesting differentials within the society for access to high-quality food. Growth appears to be stunted with a clear catch-up phase in late childhood against archaeological and modern comparative data. Overall, there is little skeletal evidence of disease in the non-adult sample. Adults display high frequencies of LEH (61.5%), infectious disease (58.3%) and DJD (49.5%). Yet, in diachronic comparison, Sidon reflects the overall trend of moderate disease load in relative political and economic stability during the MBA.

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### Are Male Orangutans a Threat to Infants? Mother-offspring Interactions with Males in Wild *Pongo pygmaeus wurmbii*

AMY M. SCOTT and CHERYL D. KNOTT

Anthropology, Boston University

Due to the semi-solitary social organization of orangutans, little is known about the nature of interactions between males and mother-offspring dyads. Orangutan socioecology and life history predict a lack of male care and vulnerability to infanticide. Promiscuous and post-conceptive mating by female orangutans increase paternity confusion, an anti-infanticide strategy. If males present an infanticide risk, then mother-offspring dyads will avoid encountering males and will enter closer proximity in the presence of males. We tested these hypotheses using long-term data collected in Gunung Palung National Park, Borneo, Indonesia, from 1994-2016. We found that mothers with offspring under 6 years encounter males significantly less often than mothers with dependent offspring over 6 years and adult females without offspring ( $\chi^2 = 90.183$ ,  $df=2$ ,  $p < 0.001$ ). This may be due to a combination of male avoidance by mothers with young offspring and an increase in male-female interactions as females resume cycling. However, the distance between a mother and her dependent offspring is significantly shorter in the presence of males than when the mother-offspring dyad is alone or in the presence of an unrelated female ( $R^2 = 0.788$ ,  $n = 360$ ,  $p < 0.001$ ). This suggests that

the presence of males is threatening to mother-offspring dyads. We also use descriptive GPS data from simultaneous follows to show how males and mothers are moving through the forest in relation to each other. These data, along with female mating behavior, suggest that infanticide is a selective pressure shaping female orangutan mating and mothering behavior.

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### Stable carbon and nitrogen isotopes of dental calculus from Greenlandic Inuit are consistent with a protein-rich and fat-rich diet

G RICHARD SCOTT<sup>1</sup>, SIMON R. POULSON<sup>2</sup> and NIELS LYNNERUP<sup>3</sup>

<sup>1</sup>Anthropology, <sup>2</sup>Geological Sciences & Engineering, University of Nevada, Reno, <sup>3</sup>Forensic Anthropology, University of Copenhagen

Stable carbon and nitrogen isotope compositions of dental calculus generally correspond well with results from proteinaceous biomaterials, although calculus is not equivalent to collagen or any other protein. The C/N molar ratio for proteins such as collagen is 2.8 to 3.2, whereas for calculus, molar C/N varies from 5.8 to over 12 due to the presence of nitrogen-free organic compounds in addition to the presence of protein. Nevertheless, dental calculus still shows potential utility as a biomaterial for the study of paleodiet. For the first time, we analysed the dental calculus of 30 Greenlandic Inuit (five of which had hair available) for stable isotopes, a population previously studied using stable isotopes of collagen. A mean  $\delta^{15}N$  of +19.9‰ for calculus and +19.4‰ for hair and a mean  $\delta^{13}C$  of -18.2‰ for calculus and -15.9‰ for hair, indicates calculus and hair (and collagen)  $\delta^{15}N$  values are highly congruent while calculus  $\delta^{13}C$  is significantly lighter than hair (and collagen)  $\delta^{13}C$ . Nevertheless, the calculus and collagen results both show a strong positive correlation between  $\delta^{15}N$  and  $\delta^{13}C$ , and isotopic values for both calculus and collagen are consistent with a diet rich in protein derived from marine resources. The lighter  $\delta^{13}C$  values for calculus vs. hair and collagen may be due to calculus incorporating a significant component of carbon derived from isotopically-light lipids that occur in abundance in a typical fat-rich Inuit diet, whereas protein-only biomaterials (e.g. hair, collagen) would not incorporate this isotopically light carbon.

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### The role of the hypocone in primate diversification: a test of the key-innovation hypothesis

JEREMIAH E. SCOTT

Department of Anthropology, Southern Illinois University Carbondale

The hypocone has been identified as a possible key innovation in mammals. According to this hypothesis, the success of certain clades, measured in terms of species richness, is related to the hypocone altering molar function in ways that allowed lineages to expand into previously unavailable dietary niches. This study tests the applicability of this hypothesis to primates. Using likelihood methods that can detect trait-dependent differences in speciation and extinction, I examined the association between hypocone presence and increased net diversification rates (speciation rate minus extinction rate) across a time-calibrated molecular phylogeny of 249 primate species. A trait-dependent model with separate diversification rates for each character state (present > absent) performed slightly worse than the single-rate null model, but the latter model did not provide a clearly superior fit to the data ( $\hat{I}^{\text{AICc}} = 0.82$ ). Further analysis using models that specified greater complexity in diversification dynamics detected rate heterogeneity, but this variation was not obviously related to the hypocone. The top-ranked model in this set indicated greater net diversification in cercopithecoidea versus other primates, while the second-ranked model ( $\hat{I}^{\text{AICc}} = 1.09$ ) contrasted anthropoids (greater net diversification) with strepsirrhines and tarsiers. These results suggest that if hypocone acquisition has shaped patterns of primate diversity, it did not leave an unambiguous signal. The recent burst of diversification in Cercopithecoidea may be related to the hypocone, given this cusp's structural role in bilophodonty, but this analysis cannot distinguish the effects of bilophodonty from the influence of other aspects of cercopithecoidea biology.

### Diet and Social Complexity in the Atacama Desert of Northern Chile (AD 700 – 1100)

RACHEL M. SCOTT<sup>1</sup>, SIÂN E. HALCROW<sup>1</sup>, VIVIEN STANDEN<sup>2</sup>, BERNARDO ARRIAZA<sup>3</sup> and CHRISTOPHER W. SCHMIDT<sup>4</sup>

<sup>1</sup>Department of Anatomy, University of Otago,

<sup>2</sup>Departamento de Antropología, Universidad de Tarapacá, <sup>3</sup>Instituto de Alta Investigación, Universidad de Tarapacá, <sup>4</sup>Department of Anthropology, University of Indianapolis

Despite being the driest inhabited desert in the world, the Atacama in Northern Chile has a long history of occupation with groups utilizing the rich marine resources along the Pacific Coast from c. 8000 BC. Later, agriculture was established and settlement extended into the inland valleys, leading to larger settlements and increased social organization. During the Middle Horizon (c.

AD 700 – 1100) there is evidence that interaction spheres widened and the types of exchanged resources in the region increased. The subsistence base in the western valleys expanded and incorporated a range of products including maize, quinoa, beans, chili peppers, dried potatoes, and marine resources including dried fish. It is during this phase that there is archaeological evidence for stratified social structures within valley communities. Published bioarchaeological evidence shows there was an increase in infant mortality and childhood stress, and sex differences in dental conditions during this time. However, our analysis of the physiological indicator of stress *cribra orbitalia* in males ( $n = 3/20$ ) and females ( $n = 0/27$ ) showed no significant difference in prevalence between the sexes ( $p = 0.07$ ). To assess food allocation and consumption that may be indicative of social organization we investigate sex differences in the diet of adults ( $n = 31$ ) from the Azapa Valley, Northern Chile using dental microwear texture analysis. Differences in microwear signatures between the sexes may suggest preferential access to particular food resources that may have been one contributor to high infant mortality had mothers not consumed a sufficiently nutritious diet.

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### Food toughness and dental microwear anisotropy

ROBERT S. SCOTT<sup>1</sup>, BARTH W. WRIGHT<sup>2</sup>, KRISTIN A. WRIGHT<sup>3</sup>, CALLUM ROSS<sup>4</sup>, ADAM VAN CASTEREN<sup>5</sup>, MARIANA FOGAÇA<sup>6</sup>, DOROTHY M. FRAGASZY<sup>7</sup>, CLAIRE MARCIL<sup>1</sup> and DAVID S. STRAIT<sup>8</sup>

<sup>1</sup>Anthropology, Rutgers University, <sup>2</sup>Anatomy, Kansas City University of Medicine and Biosciences, <sup>3</sup>Biomedical Graduate Studies, Kansas City University of Medicine and Biosciences, <sup>4</sup>Organismal Biology & Anatomy, University of Chicago, <sup>5</sup>Evolutionary Anthropology, Max Planck Institute for Evolutionary Anthropology, <sup>6</sup>Psychology, University of Sao Paulo, <sup>7</sup>Psychology, University of Georgia, <sup>8</sup>Anthropology, Washington University in St. Louis

Anisotropic dental microwear textures have been understood as a result of diets of mechanically tough foods. More folivorous diets are commonly considered mechanically tough compared to more frugivorous diets. Comparative analysis of primate microwear has also found that primate folivores tend to have dental microwear textures that are more anisotropic compared to primates with other diets. However, recent work where toughness of foods eaten by different primate species was measured and the median toughness of primate diets was quantified found that folivores as a group did not have significantly tougher diets than frugivores undermining a linkage between tough diets and folivory. Here we compare median toughness and dental microwear anisotropy for a sample of nine

primate species. This sample draws on previously published data and new data on *Cebus olivaceus* and *Sapajus apella*. While the sample is small, comparison of food toughness and dental microwear textures has been impossible without a comparative data set of measured diet toughness for a range of primate species. No significant correlation was found between median diet toughness and the frequency of anisotropic microwear. These results suggest that alternative explanations for the association between folivory and anisotropic dental microwear are likely important. These may include the presence of phytoliths in leaves, the nature of exogenous grit found on leaves, and morphological characteristics of leaves that influence their mastication.

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### Sex Estimation from the Scapula in a Contemporary Thai Population

SHELBY E. SCOTT<sup>1</sup>, TANYA R. PECKMANN<sup>2</sup>, SUSAN MEEK<sup>3</sup> and PASUK MAHAKKANUKRAUH<sup>4</sup>

<sup>1</sup>Department of Anthropology, Saint Mary's University,

<sup>2</sup>Department of Anthropology, Saint Mary's University,

<sup>3</sup>Department of Biology, Saint Mary's University,

<sup>4</sup>Excellence Center of Osteology Research and Training Center, Department of Anatomy, Faculty of Medicine, Chiang Mai University

Approximately 65 million people live in Thailand. The effects of climate change, including higher surface temperatures, floods, droughts, severe storms and sea level rise, may contribute to increased numbers of mass disasters in the region. It is imperative that forensic anthropologists have access to sex estimation methods developed from a modern Thai population. The goal of this project is to evaluate the accuracy of sex estimation discriminant functions, created using modern Mexican and Greek populations, when applied to a modern Thai sample. The sample included 191 individuals (95 males and 96 females) with age ranges from 19 to 96 years old. The length of the glenoid cavity (LGC) and breadth of the glenoid cavity (BGC) were measured. Overall, when the Mexican and Greek discriminant functions were applied to the Thai sample they showed higher accuracy rates for sexing female scapulae (83% to 99%) than for sexing male scapulae (53% to 92%). Size comparisons were made to Chilean, Mexican, Guatemalan, White American, and Greek populations. Overall, in males and females of the Thai sample, the scapulae were smaller than in the Chilean, Mexican, White American, and Greek populations. However, the male and female Thai scapulae were larger than in the Guatemalan sample. Population-specific discriminant functions were created for the Thai population with an overall sex classification accuracy rate of 83% to 88%.

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### **Aye-ayes (*Daubentonia madagascariensis*) are not just deadwood specialists: Assessing the importance of live trees to larval foraging**

TIMOTHY M. SEFCZEK<sup>1</sup>, DOMENICO RANDIMBIHARINIRINA<sup>2</sup>, BRIGITTE MARIE RAHARIVOLOLONA<sup>2</sup>, DESIRE RABEKIANJA<sup>3</sup> and EDWARD E. LOUIS, JR.<sup>3,4</sup>

<sup>1</sup>Anthropology, The Ohio State University, <sup>2</sup>Mention Anthropologie et Développement Durable, Ecole Doctorale Sciences de la Vie et de l'Environnement, University of Antananarivo, <sup>3</sup>Conservation and Research, Madagascar Biodiversity Partnership, <sup>4</sup>Center for Conservation and Research, Omaha's Henry Doorly Zoo and Aquarium

Aye-ayes (*Daubentonia madagascariensis*) are known to consume a variety of resources; however, they are most frequently identified as deadwood specialists. Recent evidence suggests that aye-ayes in Torotorofotsy, Madagascar may forage for larvae in live trees as often as deadwood. In order to determine the extent that larvae foraging co-varied with habitat type, we examined aye-aye foraging in two forests with differing levels of disturbance, Kianjavato, a disturbed forest, and Torotorofotsy, a continuous forest. We recorded feeding behaviors of two adult males aye-ayes at Kianjavato (October 2013–October 2014), and one male and one female aye-aye at Torotorofotsy (July 2014–December 2015), both in Madagascar. During focal animal follows, we recorded behavior every five minutes, for a total of 373 hours at Kianjavato and 383 hours at Torotorofotsy. Aye-ayes at Kianjavato used deadwood most often ( $p < 0.001$ ), average feeding bout length did not differ between live trees and deadwood ( $p = 0.114$ ). Aye-ayes at Torotorofotsy relied more on live trees ( $p < 0.001$ ), but average feeding bout length was longer at deadwood sites ( $p < 0.001$ ). Our results show that aye-ayes feeding on insect larvae in the continuous forest of Torotorofotsy use living trees more readily than deadwood. We conclude that insect larvae foraging for aye-ayes are habitat dependent and may not be predominantly deadwood specific, as often predicted. These results have important implications for conservation management strategies and for understanding broader aspects of aye-aye ecology.

*Madagascar Biodiversity Partnership, Omaha's Henry Doorly Zoo and Aquarium, Margot Marsh Biodiversity Foundation, Conservation International, Zoological Society of San Diego, The Ahmanson Foundation, OSU AGGRS and OSU Larsen Research Grant.*

### **An additional caenopithecine adapiform primate from the late Eocene of Egypt**

ERIK R. SEIFFERT<sup>1,2</sup>, DOUG M. BOYER<sup>3</sup>, JOHN G. FLEAGLE<sup>4</sup>, JONATHAN M.G. PERRY<sup>5</sup>, HESHAM M. SALLAM<sup>3,6</sup> and GREGG F. GUNNELL<sup>2</sup>

<sup>1</sup>Cell and Neurobiology, University of Southern California, <sup>2</sup>Division of Fossil Primates, Duke Lemur Center, <sup>3</sup>Evolutionary Anthropology, Duke University,

<sup>4</sup>Anatomical Sciences, Stony Brook University,

<sup>5</sup>Center for Functional Anatomy and Evolution, Johns Hopkins University, <sup>6</sup>Mansoura University Vertebrate Paleontology, Mansoura University

The adapiform primate subfamily Caenopithecinae is currently represented by two genera from the late Eocene of Egypt (~34 Ma *Aframomius* and ~37 Ma *Afradapis*) and one from the middle Eocene of Switzerland (~43 Ma *Caenopithecus*). Middle Eocene *Adapoides* (China), *Darwinius* (Germany), and *Mahgarita* and *Mescalerolemur* (U.S.A.) might also be caenopithecines, but this placement is not unanimously supported by recent phylogenetic analyses. Based on the limited craniodental and postcranial remains available, definitive caenopithecines have been reconstructed as slow-climbing and at least partially folivorous species. They are notable for having either greatly reduced (*Aframomius* and *Caenopithecus*) or lost (*Afradapis*) their upper and lower second premolars. Work at the ~37 Ma *Afradapis*-bearing Locality BQ-2 in the Fayum Depression of Egypt has led to the recovery of a new caenopithecine genus and species that is represented by numerous isolated teeth as well as partial mandibles, maxillae, and possibly a few fragmentary postcranial bones. As in *Afradapis* and *Caenopithecus*, the new species has upper molars that bear large hypocones, a W-shaped arrangement of the buccal crests, and mesostyles, but is distinct in being quite small and showing a relatively dramatic distal increase in molar size. The new species further expands primate diversity in the earliest late Eocene communities of northeast Africa, and increases the morphological disparity of African caenopithecines. Differences in size and morphology between the new genus and sympatric *Afradapis* suggest that African caenopithecines must have had a much more ancient origin, presumably well into the late middle Eocene, if not earlier.

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### **Hominoid scapular morphology suggests a generalized last common ancestor**

MICHAEL S. SELBY<sup>1</sup> and C. OWEN LOVEJOY<sup>2</sup>

<sup>1</sup>Department of Biomedical Sciences, Georgia Campus, Philadelphia College of Osteopathic Medicine, <sup>2</sup>Department of Anthropology and School of Biomedical Sciences, Kent State University

Despite locomotor differences, African apes have been considered simple size vicars, and a recent analysis of hominid scapular morphology has suggested an African ape-like human ancestor. However, fossil evidence suggests that humans did not evolve from a chimpanzee-like ancestor. To compare hominoid scapulae, we conducted four discriminant function analyses (DFAs) that included a broad sample of anthropoids. To limit size issues, we used five scapular angles that reflect overall shape. All DFAs yielded highest

loadings for spine orientation, glenoid-vertebral border position, spine-axillary border angle, and inferior angle. At least 74% of cases were correctly assigned. In the initial DFA, apart from one gorilla grouped as a chimpanzee, African apes and humans were distinct from one another. We then conducted three DFAs in which gorillas, chimpanzees, and humans were each initially unclassified, and then assigned to the distribution *post hoc*. When this procedure was followed, only one gorilla was identified as a chimpanzee, whereas 16 of 29 were categorized as *Lagothrix*. All 29 chimpanzees were grouped as *Ateles*. No human was categorized as an African ape, whereas 15 of 28 were classified as *Alouatta*. Chimpanzees were similar to *Ateles* in having a more cranially oriented glenoid, more highly angled spine, and narrower scapula than do gorillas, which are more similar to the predominantly clambering *Lagothrix*. Group centroids also placed gorillas closer to humans, suggesting that both likely lie closer than chimpanzees to a generalized ancestor for extant hominoids, consistent with a more generalized common ancestor as exhibited by *Ardipithecus ramidus*.

### **First 3D dental topographic analysis of the enamel-dentine junction in non-primate euarchontans: investigating development, diet, and taxonomy**

KEEGAN R. SELIG and MARY T. SILCOX

Department of Anthropology, University of Toronto, Scarborough

The enamel-dentine junction (EDJ) is the interface between the enamel and the underlying dentine. The developing EDJ also serves as a blueprint to the outer enamel surface (OES) and is therefore thought to be informative to studies of taxonomy, development, and other aspects of biology. Previous studies of EDJ morphology have largely dealt with extinct hominids and extant primates. This research is one of the first to make use of an entirely three-dimensional means for the quantification of EDJ and OES form by use of dental topographic analysis (DTA), and is the first to use these methods in non-primate members of Euarchonta.

An analysis of 15 taxa (10 treeshrew; 2 dermopteran; 3 primates; N>26 individuals) was conducted using MorphoTester. Measures of relief and complexity indicate that OES morphology is highly constrained by the EDJ in all taxa. This is suggestive of similar processes of dental development across extant euarchontans, though the degree to which these surfaces are correlated differs among major taxonomic groups, likely reflecting taxonomic and/or functional differences. Because the EDJ influences occlusal morphology, its study also informs an understanding of diet in cases where the enamel is broken or worn. With respect to treeshrews, the limited observational data on diet indicates

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mixed feeding, while the DTA results show their molars are best adapted to eating insects, suggesting a key role for that resource. Overall, study of the EDJ has led to insight into the developmental processes across Euarchonta and the dietary context of the more poorly documented euarchontans.

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### Mechanical Diet and its Role in Evolutionary Anthropology

HANNAH SELVEY and OLIVER PAINE

Anthropology, University of Colorado Boulder

The mechanical properties of diet are key drivers of variation in cranial morphology both within and across species. The habitual processing of mechanically challenging foods requires more masticatory effort over time and thus, should select for cranial robusticity. The evolution of robust cranial features in *Paranthropus* (e.g., flared zygomatics, sagittal crest) was likely a response to the consumption of mechanically challenging foods. Here we examine how the presence or absence of such foods in the diet of *Panthera leo* can affect its cranial morphology. We demonstrate how mechanically challenging foods exert strong influence on cranial growth and development as a means to explore how habitual use of these foods might select for increased cranial robusticity over generations.

We compare the skulls of wild vs. captive lions whose diets present high mechanical challenge and low challenge respectively. The oral processing of skin, raw meat, and bone by wild lions requires far more effort than the domesticated animal meat (often ground and preprocessed) fed to captive lions. Cranial measurements related to mastication were taken and significant differences exist between our captive and wild samples, suggesting that increased mechanical challenge directly influences the enhancement of cranial robusticity. Furthermore, ratios of these measurements were used in a discriminant function analysis that successfully predicts the captivity status of our specimens. If the mechanical properties of diet significantly influence within-species variation, they likely exert strong evolutionary pressure as well.

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### Testosterone as a Predictor of Dispersal Strategies in Geladas

SHARMI SEN<sup>1</sup>, CAITLIN BARALE<sup>2</sup> and JACINTA BEEHNER<sup>1,3</sup>

<sup>1</sup>Anthropology, University of Michigan, <sup>2</sup>Ecology and Evolutionary Biology, Princeton University,

<sup>3</sup>Psychology, University of Michigan

In taxa where males exhibit multiple reproductive strategies, testosterone may organize and activate differences in morphology and behavior. These differences characterize

important life history events such as dispersal, attainment of reproductive maturity, and age at first reproduction. We conducted a longitudinal study to examine how early development influences male dispersal decisions (i.e., timing of dispersal and dispersal destination) in geladas (*Theropithecus gelada*). At dispersal, gelada males can temporarily join a bachelor group and then join a reproductive unit as a dominant male (high fitness) or directly join a reproductive unit as a subordinate male (low fitness). Bachelor males eventually join units as either dominants or subordinates; but, importantly, subordinate males have never been observed to rise to dominant status. We studied 41 juvenile males with known ages from 9 reproductive units in the Simien Mountains National Park, Ethiopia. Testosterone was extracted from fecal samples and social integration was measured using social network analyses. First, we found that males with lower T than their same-age peers dispersed at younger ages than males with higher T ( $R^2 = 0.37$ ,  $F_{1,21} = 11.78$ ). Second, males that were well-integrated in the juvenile social network dispersed at older ages than males that were poorly-integrated ( $R^2=0.45$ ,  $p=0.003$ ). And, third, males that dispersed directly to reproductive units (as subordinate males) had significantly lower T compared to males that dispersed to bachelor groups ( $U=18$ ,  $z = -2.1$ ,  $p<0.05$ ). These results demonstrate that early social environment may have a significant impact on future reproductive success for gelada males.

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### Childhood stress among the Postclassic Maya of Mayapan

STANLEY SERAFIN

School of Human, Health & Social Sciences, Central Queensland University

Nearly forty years ago, Sabloff and Rathje hypothesized that living standards for most Maya were better in the Postclassic than in the Classic period (Rathje, 1975; Sabloff and Rathje, 1975). While the reconstruction of past health has been a traditional focus of Maya skeletal studies, most have focused on the Classic period. This study aims to redress this shortcoming by presenting the results of analyses of indicators of childhood stress in the Mayapan skeletal series, the largest Late Postclassic sample presently available. Data from porotic hyperostosis and linear enamel hypoplasias (LEH) are integrated with archaeological context from diverse sectors at the site.

A relatively high frequency of porotic hyperostosis (60%, N=40) was observed. Taken with together with previous research that found relatively low frequencies of caries, the elevated frequency of porotic hyperostosis was likely due to high

parasitic and infectious disease loads rather than iron-deficiency anemia.

Lower LEH frequencies were observed in Mayapan's ceremonial center (31% of maxillary central incisors, N=16) compared with residential areas (90%, N=10). We interpret this as indicating that individuals buried outside the monumental zone were more likely to survive episodes of stress during childhood. This was expected based on the high proportion of possible sacrificial victims in the site center sample as well as the concentration of relatively elaborate burials outside the site center.

The results presented here contribute to reconstructions of the temporal and regional diversity in Maya health.

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### Initiation of Permanent Premolar Tooth Crypt Formation in Individuals with Premolar Agenesis

MAJA ŠEŠELJ

Anthropology, Bryn Mawr College

Among the participants of the Fels Longitudinal Study, the second premolar is the second most frequently congenitally absent tooth (N=30). In a subset (N=9) of individuals with observed second premolar agenesis, there is radiographic evidence of alveolar bone resorption under the roots of the erupted deciduous second molar. The radiographic appearance is similar to the early stages of permanent tooth crypt formation, with an area of increased radiolucency under the deciduous molar roots, even though the replacement tooth fails to form. This loss of bone was present between the ages of 3.5 and 6 years, though in one case it was observed at age 8 years, after which the radiolucent area disappeared. This osteoclastic activity does not appear to be associated with permanent premolar formation, nor with the odontoclastic resorption of the overlying deciduous molar roots, as those teeth remained in functional occlusion for years afterwards. There is also no evidence of trauma or orthodontic interventions that could have affected alveolar bone density, and the transient nature of this phenomenon is in contrast with pathologies such as cysts or neoplasms. A similar loss of bone was not observed in cases of third molar (N=36) or second molar agenesis (N=3), but was observed in a single individual with both permanent premolars congenitally absent. These observations suggest that, in at least some individuals, the mechanisms underlying osteoclastic activity associated with early stages of permanent premolar crypt formation may be initiated independently of the calcification of the teeth themselves.

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## ABSTRACTS

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### Calcaneal trabecular structure in terrestrial and arboreal primates and marsupials: implications for the locomotor behaviour of the extinct wombat, *Phascolomys mitchelli*

DAVID A. SFORZIN<sup>1</sup>, VARSHA C. PILBROW<sup>1</sup> and DAVID C. ACKLAND<sup>2</sup>

<sup>1</sup>Anatomy and Neuroscience, The University of Melbourne, <sup>2</sup>Mechanical Engineering, The University of Melbourne

The calcaneus is a key weight bearing bone that is loaded to varying degrees of strain during locomotion. Differences in calcaneal morphology, including bone density may reflect specific bone loading patterns and assist in elucidating locomotor behaviours of extinct species.

MicroCT imaging was used to assess the trabecular structure of the calcaneus in humans (N = 10), macaques (N = 4), chimpanzees (N = 2), baboons (N = 2) and possums (N = 4), and this data was used to predict the locomotor behaviour of an extinct wombat *Phascolomys mitchelli* (N = 1). Each specimen was scanned at a voxel size of approximately 20µm and digital image analysis was used to calculate bone volume fraction (BV/TV), degree of anisotropy (DA), trabecular thickness (Tb.Th) and trabecular number (Tb.N) for two regions of interest (Scanco).

Factor analysis reveals that 90% variance accounts for separation between terrestrial (humans, chimpanzees, baboons) and arboreal (macaques, possums) taxa, with significant differences in Tb.N, Tb.Th and DA (Mann-Whitney, p<0.05). Humans differ significantly from baboons and macaques in all trabecular parameters, but do not differ from possums in Tb.Th. Chimpanzees and humans differ only in DA at the posterior calcaneus, but differ significantly in BV/TV and Tb.N on the plantar surface. The wombat clusters with baboons in all parameters.

We conclude that the trabecular structure of the posterior and plantar calcaneus differentiates between terrestrial and arboreal locomotor patterns. This study suggests that *Phascolomys mitchelli* is a terrestrial marsupial with a loading pattern similar to baboons.

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### Paleobiology, Competition and Migration in Late Pleistocene Southeast Asia

ALEXANDRA ZACHWIEJA and LAURA L. SHACKELFORD

Anthropology, University of Illinois Urbana-Champaign

Throughout the Late Pleistocene, the Southeast Asian environment changed dramatically, but pockets of tropical and temperate forests were maintained. Recent studies employing optimal foraging theory suggest that rainforests are among the most challenging for human foragers due to the large percentage of inedible, woody

plant material and small, fast animals that are difficult to catch (Piper and Rabett, 2014). Therefore, Pleistocene humans were likely reliant on animal protein, specifically medium-sized prey like pigs and cervids, placing them in direct competition with other regional predators.

Interspecific competition between humans and other predators was investigated using a competition index (CI), which calculates probable dietary overlap for all predators at a shared site based on mass-reliant prey choice and prey preference (Hertler and Volmer, 2008). Data on species interactions were collected from five Pleistocene sites in Laos and Vietnam. Body mass used to calculate CIs was estimated from molar (M1) length using species-specific regression equations (Van Valkenburgh, 1990).

From the perspective of mass-based prey choice, humans would have competed for resources with other medium- and large-sized predators hunting alone (hyenas, leopards and tigers) or in packs (dholes). This competition could have been ameliorated through either dietary or spatial partitioning. In regions where easily attainable plant resources were low, it is likely that spatial partitioning was used by lower-ranked carnivores, including humans, resulting in movement towards habitat fringes. As such, southern migration in Australasia during the Late Pleistocene should be further evaluated in the context of competition for resources with higher ranked carnivores.

*This research was supported by the University of Illinois Department of Anthropology, University of Illinois Research Board, the Beckman Institute and the Explorer's Club.*

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### Variation in prey choice and hunting efficiency by season and technology among indigenous Waiwai hunters in Guyana

CHRISTOPHER A. SHAFFER<sup>1</sup>, CHARAKURA YUKUMA<sup>2</sup>, ELISHA MARAWANARU<sup>2</sup>, PHILLIP SUSE<sup>2</sup> and MARISSA S. MILSTEIN<sup>3</sup>

<sup>1</sup>Department of Anthropology, Grand Valley State University, <sup>2</sup>Masakenari Village, Konashen Indigenous District, <sup>3</sup>Veterinary Population Medicine Department, University of Minnesota College of Veterinary Medicine

We studied the subsistence hunting behavior of Waiwai forager-horticulturalists in the Konashen Community Owned Conservation Area (KCOCA), Guyana to determine the factors influencing harvesting decisions and assess long-term sustainability. We conducted 42 hunter follows, during which we collected data on catch-per-unit effort (CPUE), hunter ranging behavior, prey choice (encounter rate vs. pursuit rate), and kill rate (individuals killed per prey group encounter). Hunter self-monitoring data were obtained from fifteen hunters from August 1, 2014-August 1, 2015. The fifteen sampled hunters harvested a total of 343 individuals from thirty species during

564 recorded hunts, with a total prey weight of 4,452 kg. The most important species by weight were tapir, paca, white-lipped peccary, and spider monkey. 79% of prey harvested during hunter follows and 82% of prey recorded on hunter-self monitoring forms were killed with shotguns. Shotgun hunting was much more efficient than bow and arrow hunting, with kill rates of 1.12 individuals/group encounter and 0.21 respectively. CPUE was significantly higher with shotgun and significantly negatively correlated with distance from the village. Shotgun hunters were significantly more likely to ignore small game than bow hunters. Hunting frequency, prey choice, and efficiency showed high seasonal variation. Almost all primates were harvested during the May-August wet season and 50% of all hunts took place during this time. Wet season hunts were also significantly more likely to be successful, although mean CPUE was similar across months. We examine our results in the context of resource maximization and discuss their implications for primate conservation.

*Funding was provided by the American Association of Physical Anthropologists, Conservation International, the International Primatological Society, Grand Valley State University, and the University of Minnesota - College of Veterinary Medicine.*

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### Studying Population Genetics in War Time: Syria and Iraq According to Genographic Database

MICHEL SHAMOON-POUR<sup>1</sup>, GREGORY VILSHANSKY<sup>2</sup> and MIGUEL G. VILAR<sup>2</sup>

<sup>1</sup>Freshman Research Immersion (FRI), Department of Anthropology, Binghamton University, <sup>2</sup>Science and Exploration, National Geographic Society

With one out of every 113 individuals seeking foreign asylum, 2016 lays witness to one of the largest mass displacements of global populations on record. The growth in the number of refugees and immigrants in the past decade is in part due to the ongoing war and conflict in Syria and Iraq, which has led to forced displacement of millions and consequent demographic changes across Mesopotamia and the Levant. This is while the numerous ethnic, linguistic and religious identities of native populations in these regions remain underrepresented in anthropological studies. As conflict currently prevents fieldwork in Syria and Iraq, we proposed using the Genographic Project database to depict a genetic picture of human diversity in this region. Results show mitochondrial DNA data for 93 Iraqis and 142 Syrians representing two different, yet highly diverse patterns. Most notably, 5% of Iraqis and 3% of Syrians belonged to Sub-Saharan African mtDNA haplogroups, whereas three Syrians had East Asian lineages, including D4g2 and A8a1, previously found among Siberian Buryats and Han Chinese. In case of Y-chromosome, 163 Syrian men represented 14 major haplogroups,

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of which J1 and J2 were the most common haplogroups and over 20% belonged to E1b. Among 128 Iraqis, J2 was more common than J1, and E1b frequency was at 5%. A notable finding was that, 9 out of 12 Iraqis representing the Mesopotamian haplogroup T were Jewish, Assyrian and Mandaean. Using Genochip data, this report also provides a rare glimpse into genomic ancestry of Syrian and Iraqi populations.

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### Trabecular anisotropy in the primate lower ilium reflects locomotor mode

DARSHANA SHAPIRO

Anthropology, Rutgers University

Studies of trabecular architecture in primate limbs have found support for a relationship between locomotion and degree of anisotropy (DA), but this has not been investigated in the pelvis. The lower ilium varies in morphology between primates using different locomotor regimes and may also vary in trabecular architecture. Taxa subjecting their ilia to greater loading (e.g., terrestrial quadrupeds) are predicted to have higher DA than arboreal suspensors. This study examined anisotropy in the lower ilia of six extant primates (n=27) via HRXCT scans. 788 volumes of interest (VOIs) sampling medial, lateral, dorsal, and ventral columns of trabecular bone were selected in ImageJ; DA was calculated in Quant3D. These data were standardized to represent homologous locations. Composite scores for each species representing relative DA were generated from the data for each column. A PCA was also performed on a reduced dataset. The composite scores suggest relative DA corresponds to locomotor mode. *Macaca*, *Pan*, and *Papio* are relatively anisotropic; *Symphalangus*, *Pongo*, and *Homo* are less so. Additionally, relationships within phylogenetic groups matched locomotor predictions for the non-human primates (*Macaca* < *Papio*, *Symphalangus* < *Pongo* < *Pan*). In the PCA, the first three PCs explained 79.1% of the variability in the data (PC1: 52.8%, PC2: 14.6%, PC3: 11.5%). Plotting PC1 by PC2 showed that *Symphalangus*, *Pongo*, and *Homo* have relatively low medial central DA, while *Pan* and *Papio* have high outliers at this location. The PCA generally agreed with the composite rankings. These results are potentially useful for reconstructing locomotion in fossil taxa.

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### Intraspecific Variation in Hominoid Vertebral Morphology: Effects of Column Position and Locomotor Adaptation

LIZA J. SHAPIRO and ADDISON D. KEMP

Anthropology, University of Texas at Austin

Recent analyses of intraspecific variation in regional numbers of vertebrae in primates and other mammals have provided valuable insights on the evolution of the spine from developmental and adaptational perspectives. However, intraspecific variation in morphology across regions of the column has received little attention. Here we used a modified Levene's test and ANOVA to compare intraspecific variation in seven morphological features across lower thoracic, lumbar and proximal sacral vertebrae, in hominoids and *Chlorocebus aethiops* (n=228). We predicted that for any given species/morphological variable, 1) there will be greater intraspecific variation in homeotic transition areas than non-transitional areas, and 2) due to biomechanical constraints, the lumbosacral transition will exhibit less intraspecific variation than the thoracolumbar transition. We also predicted that at a given vertebral level, taxa characterized by agility, vertebral flexibility and/or biomechanically demanding locomotion (*Homo*, *Hylobates*, *Chlorocebus*) will exhibit reduced intraspecific variation compared to slower, less agile taxa with stiffer spines (*Pan*, *Gorilla*, *Pongo*). Contrary to predictions, we found few significant differences in intraspecific variation across regional levels. As predicted, for most measures, variability within *Gorilla* and *Pongo* significantly exceeded that of *Homo* and *Hylobates*. Contrary to predictions, *Pan* grouped with *Homo* and *Hylobates*, and *Chlorocebus* exhibited variation intermediate between *Homo/Hylobates/Pan* and *Pongo/Gorilla*. The distinction in variability between *Pan* and *Gorilla* contrasts with their similarity in vertebral formula variation, possibly reflecting an adaptational constraint related to *Pan*'s more agile locomotion. Future research on an expanded phylogenetic sample holds promise for further understanding of the evolution of the primate spine.

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### Interpersonal violence during the Andean Early Intermediate Period and Middle Horizon

EMILY A. SHARP<sup>1</sup> and REBECCA E. BRIA<sup>2</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Department of Anthropology, Vanderbilt University

Archaeologists have long believed that the Early Intermediate Period (AD 1–700) and the early Middle Horizon (700–1000) were times of intensified violence in the north-central Andes, based on the prevalence of defensive settlements and warrior iconography. However, physical evidence of violence is lacking, particularly in highland Ancash. This study will evaluate the severity and frequency of physical violence at the site of Aukispukio. Located near the high mountain-tops of the Cordillera Blanca at 3800 masl, Aukispukio was a major settlement affiliated with

the Recuay culture. Surface collection in 2014 of above-ground tombs and rock outcrops recovered 52 complete crania. Given the prevalence of warrior-related iconography and defensive settlements, it is expected that individuals, particularly adult males, experienced high rates of physical violence. To test this hypothesis, cranial trauma analyses were performed only on crania that were at least 50% complete. Analyses followed standard osteological protocols. The type of trauma, the etiology of the injury (whether violent or accidental), the location of the wound, and the sex and age-at-death of the affected individual were recorded. Preliminary results indicate that 27 out of 52 individuals experienced one instance of cranial trauma. More males than females showed evidence of antemortem and perimortem trauma. Juveniles were also affected with lethal and sublethal wounds. To assess spatial patterning of cranial trauma, the number of wounds was examined across seven cranial regions. The highest rate of injuries, combining ante and perimortem trauma, occurred on the frontal, followed by the left and right parietals.

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### Human sickness behavior not expressed in response to the rabies vaccine

ERIC C. SHATTUCK and MICHAEL P.

MUEHLENBEIN

Anthropology, University of Texas at San Antonio

Sickness behavior is thought to be an evolutionarily adaptive means of improving host survival in the face of infection. Many behaviors (e.g., sociability) decline during sickness as a result of changes in host motivation and energetic prioritization towards mounting an effective immune response. Changes in mood, including depression, are another stereotypical outcome. Sickness behavior in humans remains underexplored, and although experiments in non-human animals indicate that changes in hormone levels likely shape sickness behavior expression, these associations have not been examined in humans.

48 participants receiving the rabies vaccine provided saliva and urine samples for hormone analysis, in addition to behavioral and mood data, across six days. Comparisons were made between pre- and post-vaccine levels of interleukin-6, testosterone, cortisol, and oxytocin. Additionally, measurements of mood, social behavior, libido, diet/calorie consumption, and physical activity were also compared.

In accord with predictions, mean IL-6 and cortisol concentrations increased slightly following vaccination, while testosterone and oxytocin decreased. However, there were no significant changes in hormone levels, mood, libido, or

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activity indicative of sickness behavior in this population.

This is one of the first attempts to examine sickness behavior in humans outside of the laboratory. Our results indicate that the rabies vaccine may not elicit a strong enough cytokine response to drive sickness behavior across multiple days. Furthermore, participant social contexts may also be important for sickness behavior expression. This project also highlights a number of methodological concerns relevant to pursuing human behavioral endocrinology research in the field, including timing of sample collection.

*This project was funded in part through awards from Indiana University's Department of Anthropology's Skomp Summer Research Feasibility program and the Graduate and Professional Student Organization.*

### **Pronogrady, not fast speed specifically, acts as a constraint on vertebral formula in mammals**

MILENA R. SHATTUCK<sup>1</sup>, LAUREN A. PETRULLO<sup>2</sup>, AMY PETERSON<sup>3</sup>, AMANDA B. LEE<sup>4</sup>, ELSKA KACZMAREK<sup>5</sup>, DEANNA M. GOLDSTEIN<sup>6</sup> and SCOTT A. WILLIAMS<sup>1,7</sup>

<sup>1</sup>Center for the Study of Human Origins, Department of Anthropology, New York University,

<sup>2</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University,

<sup>3</sup>Human Origins Program, National Museum of Natural History, Smithsonian Institution,

<sup>4</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>5</sup>Rosenstiel School of Marine and Atmospheric Science, University of Miami,

<sup>6</sup>Department of Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, <sup>7</sup>New York Consortium in Evolutionary Primatology

Nearly all mammals possess seven cervical vertebrae, and many groups retain the primitive number of 19 thoracolumbar vertebrae (TL), implying long-term evolutionary stasis. Recently, Galis and colleagues proposed that stabilizing selection for agility and fast running canalizes variation because evolutionary change in TL number can result in incomplete homeotic changes at the lumbo-sacral boundary; the resulting partially sacralized vertebrae might potentially impede intervertebral movement and leave individuals at a disadvantage for chasing prey or escaping predators. Galis et al. showed that slow-running species are characterized by higher levels of variation than fast-running species in two clades (Carnivora and Artiodactyla), with two additional clades composed of slow-moving members (Afrotheria and Monotremata) showing elevated levels of TL variation. We test the hypothesis proposed by Galis and colleagues by including additional clades of mammals (Marsupalia, Xenarthra, Rodentia, and Primates) in our analyses. Our results do not fully support Galis et al.'s hypothesis: slow-running species do not have elevated levels of variation in TL number compared to fast-moving species. Rather, we find

that mammals adapted to antipronogrady positional behaviors (e.g., hominoid primates, sloths, lorises) and others with distinct, non-pronogrady body plans (e.g., bats, cetaceans) are characterized by high levels of variation. This suggests that pronogrady, not strictly the need for fast speed, might be the source of stabilizing selection and canalization on TL number in mammals. Release of this constraint in hominoids may have allowed for the evolution of the diverse locomotor behaviors observed in this clade.

### **Agency and objectivity: Working together towards better science**

HEATHER SHATTUCK-HEIDORN

Human Evolutionary Biology, Harvard University

Science is a social process. As scientists, our positionality influences many aspects of our work, including choices around research directions, hypothesis formulation, or methodology. When we incorporate diverse perspectives into the research process, we move towards having a more objective science, where heterogeneous concerns and priorities are reflected in our research agendas and methodologies. While the academy struggles to retain and support diversity among scientists, as biological anthropologists, we often conduct research with populations with different social histories, background beliefs, or assumptions. Many of these groups are marginalized in their access to the enterprise of science, except as subjects.

This presentation is an exploration of methods biological anthropologists use to increase the access of participants to the research process, and some of the challenges faced in incorporating these methods within standard scientific practice. In particular, opening more aspects of the research process to participants can be difficult to coordinate with the timelines of funding proposals and the expectations of the IRB, especially when working with "vulnerable" populations. I also examine difficulties in integrating these research choices with dissertation and early career work, reflecting on challenges I encountered in my own dissertation research, in which I worked with an immigrant population which likely had undocumented members. This presentation aims to offer concrete suggestions for how scientists can recognize the agency of our participant populations, and spark discussion of how we can implement these strategies at our field sites and projects.

### **Evolutionary Implications of Variability and Rates of Change in the Primate Lumbo-sacral Plexus**

BRIAN M. SHEARER

Department of Anthropology, CUNY Graduate Center, NYCEP, New York Consortium in Evolutionary Primatology

The primate hindlimb is an anatomical complex that has undergone major evolutionary shifts, both in relation to the primitive mammalian condition, and among/within primate clades. These changes are reflected in skeletal limb anatomy and patterns of use in primates, and also in the presence/absence, function, and morphology of the muscular system. However, whether such changes also involve corresponding shifts in non-muscular soft tissues is not well understood, and yet is critical for understanding the patterns of limb evolution as a whole in primates.

One major question that results from this deficit concerns whether the primate peripheral nervous system has reconfigured to match changes in its muscular correlates in the notably variable primate hindlimb. To test this question, I here compare the anatomy of the primate lumbosacral plexus (the source of distribution of neural innervation for the lower limb) and hindlimb musculature for 20 species of extant primates gathered via primary dissection. Specimens from all genera of apes, and representatives from the major clades of cercopithecoids, platyrrhines, and strepsirrhines are included. An analysis of characters derived from the lumbosacral plexus and its path of distribution to its muscular correlates suggests that this structure is stable over evolutionary time, and primarily varies in its contributions from different spinal levels related to the number of pre-sacral vertebrae, rather than to shifts in distal muscle morphology. This suggests that the primate peripheral nervous system is a relatively conservative structure, and may be responding to different evolutionary pressures than either muscle or bone.

*This research has been funded in part by the NSF GRFP.*

### **Should I Stay or should I Go? Using Hinde's Proximity Index to understand Changing Social Relationships in Hylobatid Groups as Offspring Mature**

ALEXANDRA C. SHELDON<sup>1</sup> and GABRIELLA SKOLLAR<sup>2</sup>

<sup>1</sup>Primate Behavior and Ecology, Central Washington University, <sup>2</sup>Director, Gibbon Conservation Center

Proximity is helpful in understanding primate relationships, particularly as offspring mature and prepare to disperse. To quantify this in gibbons, I recorded all instances of approach and retreat behaviors that the focal individual gave and received during 15 minute samples of five groups of captive gibbons at the Gibbon Conservation Center over 350 hours. I divided the focal animals into four age categories: infant, age zero to three years (n=4); juvenile, age three to five years (n=2); adolescents, age five to eight years (n=5) and adults, over eight years (n=9). I hypothesized that infants would maintain the most proximity to others while adolescents would maintain the most distance from others. I calculated proximity

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using Hinde's proximity index:  $A1/(A1+A2) - R1/(R1+R2)$ , where A and R represent the number of times two individuals approached or retreated from each other. If the index is positive, individual 1 is more responsible for maintaining proximity with individual 2. Infants were most responsible for maintaining proximity to all individuals in their groups but did not favor one age class more than the others ( $F(3, 155)=.743, p=.528$ ). These results are consistent with the youngest individuals needing the most care and protection and being the least independent. Adolescents were most responsible for maintaining distance with all age classes, particularly adults and other adolescents ( $F(3, 172)=4.627, p<.004$ ). Because both males and female gibbons disperse from their natal groups, maintaining distance could indicate an adolescent's readiness to migrate. Understanding these cues can help caretakers facilitate dispersal in captive individuals.

### Pelvic morphology and stature in South Asian women

MEGHAN K. SHIRLEY<sup>1</sup>, OWEN J. ARTHURS<sup>1,2</sup> and JONATHAN CK. WELLS<sup>1</sup>

<sup>1</sup>Great Ormond Street Institute of Child Health, University College London, <sup>2</sup>Department of Radiology, Great Ormond Street Hospital for Children NHS Foundation Trust

The 'obstetric dilemma' as described by Washburn (1960) referred to an evolved compromise between two key human traits: efficient maternal bipedal locomotion and neonatal encephalization. Recently, attention has been directed to variability in the dilemma's presentation within and between populations, which is proposed to reflect ecological impacts on maternal pelvic dimensions and neonatal size. For example, maternal pelvic morphology may reflect growth patterns and hence adult stature. Relevant data are scarce, however, particularly for low-income populations. In India, secular trends have resulted in low average maternal height, whilst maternal mortality from obstructed labor is high. Pan (1929) previously reported no correlation between stature and pelvic dimensions in 36 Hindu females. We measured pelvic dimensions (bi-iliac and bi-acetabular breadth, pelvic inlet and outlet, interspinous and intertuberous diameter) using three dimensional magnetic resonance imaging in 70 nulliparous South Asian women (aged 20-28 years). Stature and tibia length were measured by manual anthropometry, and birthweight obtained by recall. Contrary to Pan, all pelvic dimensions correlated positively with height ( $r \geq 0.28; P < 0.025$ ). All dimensions except interspinous diameter correlated positively with tibia length ( $r \geq 0.28; P < 0.04$ ), and bi-iliac and bi-acetabular breadths correlated positively with birthweight ( $r \geq 0.27; P \leq 0.03$ ). These findings suggest that both fetal and early post-natal growth patterns impact adult pelvic morphology

in South Asian women, supporting the hypothesis that ecological stresses impacting growth may alter the magnitude of the obstetric dilemma. Smaller maternal pelvises may contribute to low birthweights among South Asian populations.

### Effects of Ethanol on *Porphyromonas gingivalis* in Planktonic and Biofilm Monocultures

NICHOLAS A. SHORT<sup>1</sup>, RICHARD J. LAMONT<sup>2</sup> and PAUL W. EWALD<sup>1</sup>

<sup>1</sup>Department of Biology, University of Louisville, <sup>2</sup>Department of Oral Immunology and Infectious Diseases, University of Louisville

*Porphyromonas gingivalis* is a pathogenic oral bacterium that is strongly associated with periodontal disease, but it has also been detected elsewhere in the body, including atherosclerotic plaques. Atherosclerosis is a chronic disease of the arteries characterized by chronic inflammation and cholesterol deposition within arterial walls, but the underlying causal mechanisms remain under debate. The severity of periodontitis increases linearly with alcohol consumption. Risk for developing atherosclerosis decreases with moderate increases in alcohol consumption but then increases with greater alcohol consumption. One might not expect this pattern if *P. gingivalis* contributes to atherosclerosis. This difference could be consistent with a causal role for *P. gingivalis* in atherosclerosis if periodontal pathogens are protected against alcohol when residing in dental plaque biofilm but not when they are exposed outside of the biofilm (i.e., "planktonically"). *P. gingivalis* viability and reproduction was assessed in vitro to determine how ethanol influences this bacterium in planktonic and biofilm monocultures. Lower ethanol concentrations (0.001-0.1%) inhibited planktonic *P. gingivalis* growth, and no growth was observed with exposure to 10% ethanol. Bacteria in biofilms remained viable when exposed to concentrations lower than or equal to 1% ethanol, but concentrations at or above 10% killed biofilms. Moderate alcohol consumption may decrease an individual's risk for atherosclerosis if ethanol decreases microbial proliferation by acting as a systemic antimicrobial agent. These in vitro experiments are consistent with the hypothesis that moderate alcohol consumption could protect against atherosclerosis through inhibition of planktonic bacteria but be detrimental to periodontitis through negative effects on host function.

Internal funding, University of Louisville

### An Interdisciplinary Project on the Neolithic Population of Modern Switzerland

INGA SIEBKE<sup>1</sup>, ANJA FURTWÄNGLER<sup>2</sup>, ALBERT HAFNER<sup>3,4</sup>, JOHANNES KRAUSE<sup>2,5,6</sup> and SANDRA LÖSCH<sup>1</sup>

<sup>1</sup>Department of Physical Anthropology, Institute of Forensic Medicine, University of Bern, Switzerland, <sup>2</sup>Institute for Archaeological Sciences, Archaeo- and Palaeogenetics, University of Tübingen, Germany, <sup>3</sup>Department of Prehistory, Institute of Archaeological Sciences, University of Bern, Switzerland, <sup>4</sup>Oeschger Center for Climate Change Research, University of Bern, Switzerland, <sup>5</sup>Max Planck Institute for the Science of Human History, Jena, Germany, <sup>6</sup>Senckenberg Centre for Human Evolution and Palaeoenvironment, University of Tübingen, Germany

Human skeletal remains from the Neolithic period are extremely rare and while many pile dwelling sites are known from Switzerland little is known about the inhabitants. Thus the recent discovery of a Neolithic dolmen in Switzerland with *in situ* inhumations was unexpected and might provide new information about the population. The dolmen of Oberbipp contained well-preserved skeletal remains and was documented using state-of-the-art technologies.

The aim of the project is to analyze the skeletal remains of the Oberbipp dolmen in the context of further Neolithic material from Switzerland and to gain further insights into the Neolithic "Swiss" population.

The preliminary minimum number of individuals (based on right femora) from Oberbipp is 40. Morphological analysis revealed the presence of both sexes and neonate to adult individuals. Based on the right femora a proportion of 37.5% subadults and 62.5% adults was calculated. First <sup>14</sup>C results indicate a use of the dolmen approximately 3500 – 3000 BCE. The reconstruction of complete mitogenomes of 16 individuals shows the presence of haplogroups characteristic for Early Farmers and a remarkably high frequency of haplogroup K. Stable isotopes (C, N, S, H, O, Sr and Pb), further ancient DNA and <sup>14</sup>C analyses are currently ongoing.

The preliminary results are indicative of a "normal" Neolithic population and are in concordance to other Neolithic sites in central Europe so far. The evaluation of the stable isotope data as well as the evaluation of palaeopathologies might provide additional information.

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### Horse Trail Shelter (41VV166): Understanding subsistence and lifeways in the Lower Pecos Canyonlands of Texas during the Late Prehistoric using a novel SfM approach to osteological data collection

COURTNEY C. SIEGERT, CHARLES W. KOENIG, AMANDA M. CASTANEDA, STEPHEN L. BLACK, MICHELLE D. HAMILTON, LAUREN A. MECKEL, DEVORA S. GLEIBER and SOPHIA R. MAVROUDAS  
Anthropology, Texas State University

The purpose of this presentation is to introduce attendees to the Late Prehistoric populations of the Lower Pecos Canyonlands via a burial from Horse Trail Shelter (41VV166), and to highlight the utility of Structure-from-Motion (SfM) photogrammetry as a novel method for data collection in bioarchaeological settings.

During the 2016 field season, the fragile remains of a flexed adult female were excavated from the shelter. An alluvial deposit dating to ~A.D. 1340 sealed the internment. Macroscopic examination showed compromised dental health including caries lesions, abscesses, and severe attrition. Radiographs and micro-CT scans revealed internal bone structure reflective of habitual activity. Isotopic analyses provided data on migration and subsistence patterns, and mtDNA sequencing and genome-wide SNP analysis was performed to situate this individual's maternal lineage with other available Late Prehistoric Lower Pecos genomic data. The individual's remains will be reinterred in her original burial location at Horse Trail Shelter at the end of the 2016 field season.

Throughout the excavation, serial photographs were taken to map and record the burial. Using AgiSoft Photoscan Pro software, 3D models of the burial were created and standard postcranial measurements collected using the "Draw Polyline" tool. The model was rotated on all axes to replicate standard measurements using osteometric boards and calipers. Preliminary comparative results indicate accurate osteological measurements (+/- 2mm) can be extracted from photogrammetry models. This methodology shows utility for retrieving accurate cranial and postcranial measurements using SfM in both bioarchaeological and forensic anthropological settings.

### Patterns of Handedness Among Human Populations from the Late Pleistocene to the Holocene

YUN YSI SIEW<sup>1</sup>, EFTHYMIA NIKITA<sup>2</sup>, ALISON A. MACINTOSH<sup>3</sup>, MATTHEW A. GASPERETTI<sup>3</sup>, EMMA POMEROY<sup>4</sup> and JAY T. STOCK<sup>3</sup>

<sup>1</sup>Institute of History and Philology, Academia Sinica, <sup>2</sup>STARC Department, The Cyprus Institute, <sup>3</sup>Department of Archaeology and Anthropology, University of Cambridge, <sup>4</sup>McDonald Institute for Archaeological Research, University of Cambridge

A considerable literature shows that most individuals in any given population have a preference for using their right hand for complex tasks, with a frequency varying between 74% and 96%, while no human society is reported to be predominantly left-handed. This species-wide right-handedness is a unique attribute of *Homo sapiens sapiens*. Although there is evidence that our closest primate relatives show some degree of handedness, they do not have a population-level consistency in hand use patterns as seen among human populations. Environmental and cultural influences on handedness have been intensively investigated. It is evident that every culture has different attitudes towards hand use preference. The present study investigates the asymmetrical pattern using humeral robusticity ranging from the late Pleistocene to the Holocene. In total of 1005 individuals from 53 samples were studied. The geographical regions include North America, Africa, South America, Middle East, Australia and Asia. Only slightly more than half of the studied individuals (504/1005) are right-biased asymmetry. Of the 53 samples, 29 show a left dominance and 24 indicate a right dominance, which is opposed to the mainstream assumption. It is noteworthy that the handedness investigated in this study demonstrate a regional pattern. Human populations from South America (Chile, Peru and Argentina) incline to display an asymmetry to the left, while those from Asia (China and Taiwan) and Central Europe (Germany, Serbia, Hungary, Slovakia and Czech Republic) tend to be right-handed.

*This project is funded by the Wenner-Gren Foundation (8186).*

### Endocranial anatomy of Late Paleocene (Clarkforkian NALMA) *Carpolestes simpsoni* (Plesiadapoidea, Primates) from the Bighorn Basin, Wyoming

MARY T. SILCOX<sup>1</sup>, RACHEL RUSEN<sup>1</sup> and JONATHAN I. BLOCH<sup>2</sup>

<sup>1</sup>Anthropology, University of Toronto, Scarborough, <sup>2</sup>Florida Museum of Natural History, University of Florida

Carpolestids are stem primates (plesiadapiforms) characterized by relatively large, blade-like lower fourth premolars, possibly a specialization for processing fruit. The best known carpolestid, late Paleocene *Carpolestes simpsoni*, is known from a previously reported partial skeleton that includes most of the pes, with morphology consistent with having had an opposable, nail-bearing hallux more similar to that of euprimates than other plesiadapiforms for which the relevant anatomy has been recovered.

A previously described cranium of *Carpolestes simpsoni* (USNM 482354), while somewhat crushed and distorted, is complete enough to allow for partial reconstruction of the endocranial cavity using microCT data to virtually separate

and reconfigure the relevant bones. The form of the endocast is similar to that observed in other plesiadapiforms, with large, pedunculated olfactory bulbs and a cerebrum that is narrow rostrally (suggesting small frontal lobes) and short distally, so that the caudal colliculi are exposed. Estimates of the encephalization quotient (EQ; Eisenberg equation) range from 0.36-0.41 depending on the degree of reconstruction. This range of EQs is within that calculated for *Microsypops annectens*, slightly lower than that calculated for *Ignacius graybullianus*, and higher than estimates for plesiadapids. As such, the morphology and size of the endocast suggests a brain generally similar to that of other plesiadapiforms, and lacking in more euprimate-like features such as an expanded cerebrum or reduced olfactory bulbs. The higher EQ estimates for *I. graybullianus* and *C. simpsoni* relative to other plesiadapiforms may reflect a higher energy, fruit-rich diet.

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### A novel method for estimating ancestral ontogenetic trajectories of shape change using cercopithecine crania as a test case

EVAN A. SIMONS<sup>1</sup>, STEPHEN R. FROST<sup>1</sup> and MICHELLE SINGLETON<sup>2</sup>

<sup>1</sup>Anthropology, University of Oregon, <sup>2</sup>Anatomy, Chicago College of Osteopathic Medicine, Midwestern University

We present a method for reconstructing ancestral ontogenetic trajectories using squared-change parsimony. Through an augmentation of the phylomorphospace approach, this procedure, termed an "ontophylomorphospace," allows for an investigation of the similarities and differences of ontogenetic trajectories in a phylogenetic context.

Forty-three 3D landmarks, digitized from an ontogenetic series of 556 crania representing 17 cercopithecine species from 8 genera, were superimposed using generalized Procrustes analysis. Ontogenetic trajectories of cranial shape change were computed through multivariate regression of Procrustes coordinates on molar eruption stage. To produce the ontophylomorphospace, these ontogenetic shape-change trajectories were projected onto a consensus molecular phylogeny. Ontogenetic trajectories represented by interior nodes were estimated using squared-change parsimony.

When plotted in ontophylomorphospace, the trajectories of *Allenopithecus*, *M. sylvanus*, *Lophocebus*, and *Cercocebus*—excluding *C. torquatus*, which has a trajectory most similar to larger African papionins—are similar to the reconstructed ancestral trajectory of all cercopithecines, with *Cercocebus atys* being most similar. Branches for Asian *Macaca* radiate away from the others with little overlap, indicating a

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diversification of derived trajectories relative to other cercopithecines. This differentiation is due to a faster increase of cranial base width compared to the rest of the cranium, coupled with faster growth of the neurocranium relative to the rostrum. The branches of the larger African papionins cross each other to occupy similar areas of ontogenetic-morphospace, indicating parallel evolution of ontogenetic trajectories between *Papio/Theropithecus* and *Mandrillus/C. torquatus*. These taxa share increased rates of nasal and anterior rostral growth, relative to the rest of the cranium.

### Host immune gene expression and viral infection status from whole blood transcriptomes in the Ugandan red colobus

NOAH D. SIMONS<sup>1</sup>, GEETA N. EICK<sup>1</sup>, MARIA J. RUIZ-LOPEZ<sup>2</sup>, COLIN A. CHAPMAN<sup>3,4</sup>, TONY L. GOLDBERG<sup>5,6</sup>, KIRSTIN N. STERNER<sup>1</sup> and NELSON TING<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Oregon,

<sup>2</sup>Institute of Ecology and Evolution, University of Oregon, <sup>3</sup>Makerere University Biological Field Station, Makerere University, <sup>4</sup>Department of Anthropology and School of Environment, McGill University,

<sup>5</sup>Department of Pathobiological Sciences, University of Wisconsin-Madison, <sup>6</sup>Global Health Institute, University of Wisconsin-Madison

Although advances have been made in documenting the presence of infectious disease in primates, we need a better understanding of what drives host susceptibility and response to infection in wild populations. The Ugandan red colobus (*Procolobus rufomitratus tephrosceles*) is a natural reservoir for recently described lineages of simian immunodeficiency virus (SIV<sub>krc</sub>) and simian hemorrhagic fever-like viruses (KRCV-1, KRCV-2), all of which cause disease outbreaks in captive macaques and have high zoonotic potential. To improve our understanding of natural host response and susceptibility to infection, we generated an RNA-seq dataset from 29 red colobus individuals from Kibale National Park, Uganda. We used a modified PAXgene protocol for whole blood and sequenced a globin-depleted mRNA library on three NextSeq runs. We obtained an average of 33.9 million reads per individual, with an average of 64.2% mapping to the macaque genome. We also inferred individual infection status of SIV<sub>krc</sub>, KRCV-1, and KRCV-2 by mapping unmapped reads to viral reference genomes. Sequences mapping to SIV<sub>krc</sub>, KRCV-1 and KRCV-2 were detected in 41.4%, 58.6% and 65.5% of individuals respectively. Sequences mapping to multiple viruses were detected in 62.1% of individuals. As a result, our approach simultaneously produced host gene expression profiles and viral infection status from blood collected from a wild primate. These data will be used for differential expression analyses based on infection status in order to identify host genetic

factors that may influence disease susceptibility and response to viral infection.

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### Exploring provision of care for disabled individuals in prehistoric Alabama

DIANA S. SIMPSON

Anthropology, The University of Alabama

Bioarchaeological studies exploring provision of care for the disabled in ancient societies have often received criticism due to lack of evidence or rigorous inquiry. Through the use of the bioarchaeology of care model, this line of research now has a potential standardized methodology for the identification of care in the archaeological record. The goal of this study was to apply this new model for care analysis to explore possible trends in care within prehistoric archaic populations from the Tennessee River Valley of Alabama. By performing an in depth analysis of previously identified skeletal individuals afflicted with some sort of severe trauma or degenerative disease, and employing the bioarchaeology of care model for analysis, trends in care have emerged.

Analysis has revealed that numerous individuals who suffered a severe physical impairment were able to survive for extended periods of time, even in cases where mobility would have been compromised. In several cases where degenerative diseases, for example multifocal osteomyelitis, continued to progress until death, secondary health markers, as well as mortuary treatment, support the conclusion that care of those who were unable to care for themselves was part of these mobile groups. Active care, beyond basic accommodation, in the form of mobility support, as well as provision of food, shelter, and basic hygiene, is argued to have occurred in numerous cases. This information and continued analysis can provide valuable insights into treatment of past disabled individuals and add to our overall understanding of prehistoric Alabama.

### New Field Research at Galili, Afar State, Ethiopia

SCOTT W. SIMPSON<sup>1</sup>, JAY QUADE<sup>2</sup> and HASEN SAID<sup>3</sup>

<sup>1</sup>Anatomy, Case Western Reserve University School of Medicine, <sup>2</sup>Geosciences, University of Arizona,

<sup>3</sup>Ethiopian Studies, Addis Ababa University

The paleoanthropological research potential of the sediments surrounding Mt. Galili in the Afar State of Ethiopia was first established by Y. Haile-Selassie in the late 1990s. Subsequently, a team led by H. Seidler conducted a series of field campaigns through 2010. Together, these projects discovered a number of valuable fossils,

including hominins, that verified the importance of the area and provided a biochronological and geochronological framework for the sediments that span the ca. 2.5 Ma to >4.5 Ma period.

Field research of the Mt. Galili Formation was reinitiated by our team in 2016. We conducted a short 13-day field survey of the area with the goals of collecting additional paleontological, geological, and archeological materials to better understand the biotic context during this period and provide additional age constraints on the deposits. Much of the survey focused on sediments on the middle Pliocene-aged Shabeley Laag Member with short surveys of the older Dhidinley and Lasdanan Mbrs. Altogether, a diverse array of terrestrial non-hominin (especially monkeys, suids, proboscideans, and bovids) and hominin fauna were collected. As noted by previous workers, the sediments are dominated by fluvial and lacustrine deposits with numerous intercalated air-fall tuffs and intrusive basalts. A number of geological specimens were collected and exported and await radiometric dating and tephrostratigraphic correlation analysis. Here, we will present preliminary results from the 2016 field survey.

Support for the project was from NSF BCS-1519059 (SWS) and from the University of Arizona (JQ).

### Morphological variability of Upper Paleolithic and Mesolithic skulls from Sicily

LUCA SINEO<sup>1</sup>, MANON GALLAND<sup>2,4</sup>, GIUSEPPE D'AMORE<sup>3</sup>, MARTIN FRIESS<sup>4</sup>, RON PINHASI<sup>2</sup> and ROBERTO MICCICHE' <sup>1</sup>

<sup>1</sup>SCIENZE E TECNOLOGIE BIOLOGICHE CHIMICHE E FARMACEUTICHE, UNIVERSITA DEGLI STUDI DI PALERMO, <sup>2</sup>SCHOOL OF ARCHAEOLOGY AND EARTH INSTITUTE, UNIVERSITY COLLEGE DUBLIN, <sup>3</sup>ISTITUTO DI STUDI ARCHEO-ANTROPOLOGICI, I.S.A. SCANDICCI, <sup>4</sup>MUSEUM NATIONAL D'HISTOIRE NATURELLE, UMR 7206 CNRS PARIS

Scenarios for the dispersal of *Homo sapiens* in Southern Europe and in the Mediterranean basin have been uncertain, given the scarceness of osteological samples and the simplicity of the proposed archaeologically-based settlement hypotheses. According to available data, the first anatomically modern humans entered Sicily during Late Pleistocene, coming from the Italian peninsula. A presumably small Late Epigravettian population colonised coastal sites.

We analysed Sicilian skulls from the Late Epigravettian site of San Teodoro, Eastern Sicily (AMS 14C dated at 14,500 BP) and from the Mesolithic period (14C dated from 9,500 to 8,500 BP) coming from various sites (Uzzo, Molaro, Oriente B) located on the North Western coast. The aims were to test the biological variability through time within the island as well as to evaluate the relationships of Sicilian Pleistocene hunter-gatherers with Old World populations. We also evaluated the Sicilian Mesolithic uniformity

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especially between the Uzzo and Oriente B sites, giving their vicinity and accessibility during the Early Holocene. We applied 3D geometric morphometric methods to assess size and shape variation as well as geographic and diachronic patterns. All analysed specimens, plus a comparative sample from the Old World dated to the Upper Palaeolithic to Early Mesolithic, were digitized and standard craniofacial landmarks plus semilandmarks were extracted from the 3D models.

Our results underline a high variability among the Mesolithic specimens, as well as a drastic distance from the presumed founder Palaeolithic settlers representatives (San Teodoro specimens) that have closer morphological affinities with European Palaeolithic specimens.

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### Processes that Generate Modularity in the Mammalian Skull: Implications for Primate Skull Evolution

NANDINI SINGH<sup>1</sup>, ROGER H. REEVES<sup>2</sup> and JOAN T. RICHTSMEIER<sup>1</sup>

<sup>1</sup>Anthropology, Pennsylvania State University,

<sup>2</sup>Institute of Genetic Medicine and Department of Physiology, Johns Hopkins

Morphological integration and modularity are concepts widely used to understand human and non-human primate skull evolution. However, most studies focus on patterns of covariation and correlation rather than the processes that generate those patterns. The discovery that key developmental pathways are conserved across mammalian phylogenies has allowed the use of murine models to identify processes that generate patterns and magnitudes of variation in skeletal structures. Here we use a murine model to demonstrate how an up-regulation of Sonic hedgehog (Shh), an evolutionarily conserved gene critical for dorso-ventral and medio-lateral patterning of the mammalian face, affects the cranium and mandible. Using 3D geometric morphometrics, principle components and 2B-partial least squares analyses, we quantified and analyzed the effects of a synthetic Shh-based agonist, SAG, on craniofacial and mandibular morphology of adult mice. Our results show that such an acute up-regulation of the SHH pathway has markedly different effects on the cranium, particularly on the mid-face, relative to the mandible. As SAG was administered at birth, these varied effects indicate that Shh affects cranial postnatal growth differently from the mandible. Shh signaling in the face is regulated by a Shh-responsive center in the forebrain. The variation generated by this direct connection between Shh signaling and the developing cranium indicates that for some processes the cranium and mandible are distinct modules, and demonstrates how developmental-genetic pathways differentially affect aspects of the skull. These results have important implications for

how variation in key developmental pathways can cause distinct morphological changes realized as modular patterns.

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### A novel cranial base drilling method with direct access to petrous bones for analyzing ancient DNA and preserving ancient human remains

KENDRA A. SIRAK<sup>1,2</sup>, DANIEL M. FERNANDES<sup>2,3</sup>, OLIVIA CHERONET<sup>2</sup>, MARIO NOVAK<sup>4</sup>, BEATRIZ GAMARRA RUBIO<sup>2</sup>, TÍMEA BALASSA<sup>5</sup>, ZSOLT BERNERT<sup>6</sup>, ANDREA CSÉKI<sup>7</sup>, JÁNOS DANI<sup>8</sup>, JÓZSEF ZSOLT GALLINA<sup>9</sup>, IVETT KÓVÁRI<sup>10</sup>, ORSOLYA LÁSZLÓ<sup>11</sup>, ILDIKÓ PAP<sup>6</sup>, RÓBERT PATAY<sup>12</sup>, ZSOLT PETKES<sup>13</sup>, GERGELY SZENTHE<sup>14</sup>, TAMÁS SZENICZEY<sup>15</sup>, TAMÁS HAJDU<sup>15</sup> and RON PINHASI<sup>2</sup>

<sup>1</sup>Department of Anthropology, Emory University,

<sup>2</sup>School of Archaeology and Earth Institute, University

College Dublin, <sup>3</sup>Department of Life Sciences,

University of Coimbra, <sup>4</sup>Institute for Anthropological

Research, Zagreb, Croatia, <sup>5</sup>Biomedical Centrum

Ltd., Pomáz, Hungary, <sup>6</sup>Department of Anthropology,

Hungarian Natural History Museum, <sup>7</sup>Archeodata

1998 Ltd., Polgár, Hungary, <sup>8</sup>Déri Museum, Debrecen,

<sup>9</sup>Ásatárs Ltd, Kecskemét, Hungary, <sup>10</sup>Joint Prisoner

of War/Missing in Action Accounting Command,

Hawaii, USA, <sup>11</sup>Analytical Laboratory, Hungarian

National Museum, <sup>12</sup>Department of Archaeology,

Ferenczy Museum, <sup>13</sup>Research Centre for the

Humanities, Hungarian Academy of Sciences,

Institute of History, <sup>14</sup>Department of Archaeology,

Hungarian National Museum, <sup>15</sup>Department of

Biological Anthropology, Eötvös Loránd University

Ancient DNA (aDNA) research depends on available skeletal material to study ancient peoples. However, there is often discord between maintaining the anatomical integrity of the remains and obtaining samples for aDNA research. Our previous findings suggest that the inner ear part of the petrous is the most DNA-dense region of the skeleton; we now explore a novel "cranial base drilling method" (CBDM) for accessing this region on a complete skull without causing substantial visible damage or altering anthropologically-important features.

Beginning with equal initial DNA concentration (20ng), we compared endogenous DNA yields, damage patterns, mitochondrial contamination, sex and mitochondrial haplogroup, and projected PCA position using both petrous bones (one petrous processed inside an aDNA cleanroom, the other processed in the field using the CBDM) and one postcranial element (processed inside a cleanroom) for seven Hungarian archaeological specimens spanning from the Neolithic (4500 BP) to the Avar period (8<sup>th</sup> century CE). Cleanroom-processed petrous bones yielded 18.26-73.07% endogenous DNA while petrous bones processed with the CBDM yielded 8.73-56.76% endogenous DNA, representing a reduction of 4.5-67.6%

with the CBDM. Postcranial elements yielded 0.04-5.24% endogenous DNA, representing a reduction of 92.2-95.5% when a non-petrous element is used. Though we observe a reduction in DNA quantity with the CBDM, we obtain results consistent with those produced from cleanroom processing of the petrous; in contrast, non-petrous elements often do not yield enough data for useable results. We demonstrate that the CBDM should be utilized instead of a non-petrous element in cases of a complete skull.

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### Distributions of secondary osteon collagen/lamellar morphotypes are important in avoiding stress fractures: A new hypothesis for the etiology of stress fractures

JOHN G. SKEDROS

Bone and Joint Laboratory, VA Medical Center, University of Utah

Bones resist failure during natural cyclic loading by optimizing material toughness. This can be achieved by varying predominant collagen fiber orientation (CFO) between regions of a bone in accordance with the distribution of the prevalent/predominant strain mode (tension, compression, and shear). Although this can occur independent of osteon remodeling, it is achieved in many bones through the formation of secondary osteon morphotypes (SOMs) that have distinctively different collagen/lamellar patterns that are adapted for a prevalent/predominant strain mode. Evidence from the horse racing industry suggests that microstructural adaptation via regional variations in SOM distributions helps avoid stress fractures. In the fracture-prone third metacarpal, the region most susceptible to fracture receives a strain mode (compression) during training that changes to another strain mode (shear) during racing. Consequently, typical training does not allow for SOM-mediated microstructural adaptation for the strain mode experienced during racing. This leads to microdamage accumulation and eventual fracture. Realizing that regional shifts in prevalent/predominant strain mode can precipitate stress fractures, horse racing trainers reduced the incidence of fractures by modifying training methods. I reviewed theories of the pathogenesis of stress fractures to see if any consider microstructural adaptation as important for resisting microdamage formation due to changing strain-mode distributions. Results showed that little attention is given to how bones avoid stress fractures by modifying specific microstructural characteristics. When CFO-based microstructural adaptation is considered, it is easier to explain the pathogenesis of tension vs. compression stress fractures and the etiology of atypical femur fractures in patients taking bisphosphonates for osteoporosis.

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### A Proposed Method for Determining Sex in Skeletal Remains Using the Position of the Sacral Auricular Surface

CHELSEA T. SKOOG, CAROLYN RANDO and SIMON HILLSON

Institute of Archaeology, University College London

This study aims to determine whether the position of the auricular surface of the sacrum can be used to estimate sex in human skeletal remains. A previous study by Mahato (2010) reports that the position of the auricular surface of the sacrum varies depending on the load bearing patterns of the upper body. In order to explore the idea of these patterns demonstrating sexual dimorphism, a novel methodology was developed to visually examine the position of the sacral auricular surface relative to the sacral bodies. This new method, along with a standard anthropological measurement (maximum length of the auricular surface) used in other studies on the sexual dimorphism of this region, was applied to a cohort of male and female skeletons (n=94) from the post-Medieval site of East Gate Square, Chichester, England. No significant difference was observed in the position of the sacral auricular surface between the sexes, although the measurement of the maximum length was significant. These results validate the notion that this region is sexually dimorphic (metrically), but do suggest that the position of the sacrum likely has little to contribute to sex estimation.

### The effect of activity on the reliability of body mass estimated from long bone cross-sectional area

VLADIMIR SLADEK

Dept. of Anthropology and Human Genetics, Charles University, Prague, Czech Republic

It has recently been argued that long bone cross-sectional cortical areas provide a reliable option for skeletal estimation of body mass yielding greater accuracy than estimates based on femoral head breadths. However, it has also been argued that body mass estimated from cortical areas may be subject to larger error than those estimated from femoral head breadths since cortical area is proportional not only to body mass but also reflects rigidity and strength which are affected by differences in activity. To test the impact of activity on body mass estimation we used a sample of 298 Central European Holocene femora and tibiae. Body mass equations were computed from cortical area taken at 50% of biomechanical length and from femoral head breadth; morphometric body mass was used as a baseline for estimating living body mass. Percentage prediction error was used to evaluate bias in estimated body mass relative to morphometric body mass. Size standardized cortical area adjusted for morphometric body mass was used as a proxy of activity. The results show that

percentage prediction error has a lower correlation with size standardized cortical area when body mass was estimated from femoral head breadth equations (sex-pooled sample:  $r = -0.38$  femora and  $-0.27$  tibiae) than when body mass was estimated from cortical areas (sex-pooled sample:  $r = -0.88$  femora and  $-0.86$  tibiae). Thus, these results support the view that body masses estimated from cross-sectional properties are subject to error induced by variation in activity and provides biased estimate of living body mass.

GAČR: 14-22823S: *The peoples at the end of Great Moravia: bioarchaeology and taphonomy of the new cemetery at the northeast suburb at Pohansko (Břeclav)*

### The Biomechanical Consequences of Zygomatic Arch Shape

AMANDA L. SMITH<sup>1</sup> and IAN R. GROSSE<sup>2</sup>

<sup>1</sup>Anthropology, Washington University in St Louis, <sup>2</sup>Mechanical & Industrial Engineering, University of Massachusetts at Amherst

Zygomatic arch shape is variable among mammals, ranging from virtually cylindrical to blade-like in cross section. Geometrically, the arch can be hypothesized to be a beam-like structure whose ability to resist deformation is related to its cross sectional shape. Zygomatic arches with different cross sectional shapes should thus vary in the degree to which they resist local bending and torsion due to the contraction of the masseter muscle. A stiffer arch may lead to an increase in the relative proportion of applied muscle load being transmitted through the arch to other cranial regions, resulting in elevated cranial stress. We examine the mechanics of the zygomatic arch related to mastication or biting using a series of finite element modeling experiments in which the cross section of the arch of *Pan troglodytes* has been modified to approximate idealized shapes. Overall, we find that zygomatic arch shape has local effects on strain that do not conform to simple beam theory or redundant load paths. One exception is that possessing a blade-like arch leads to elevated strains at the postorbital zygomatic junction and just below the orbits. Furthermore, modeling the arch as solid cortical bone did not have the effect of elevating strains in other parts of the face, as had been expected, but it does have a small effect on stress associated with masseter contraction. Despite its apparent simple beam-like geometry, we do not find a simple mechanical explanation related to the forces involved in mastication for the diversity of zygomatic arch shape.

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### Dietary variability and age-related behavioural changes among hunter-gatherers from Roonka, South Australia

CAITLIN B. SMITH and JUDITH LITTLETON

Anthropology, University of Auckland

Variability in both macro and microwear has been noted between and within groups of Aboriginal hunter-gatherers. This variability is thought to reflect heterogeneity in diet and activity. However, it is unclear to what extent behavioural changes during the life course play a role in this heterogeneity. Age graded changes in macro and microwear have been noted among these people, suggesting that further analysis can illuminate shared dietary and activity practices occurring within certain age groups. Additionally, ethnographic descriptions of Aboriginal society indicate that age stratification is an important part of social organisation. In order to untangle these patterns we test the extent to which variability and age graded change play out at Roonka (8,000-200 BP), a large burial site along the Murray River in South Australia using dental microwear texture analysis.

We analyse 63 permanent and deciduous second molars using a confocal microscope for four microwear texture attributes: complexity, anisotropy, heterogeneity, and textural fill volume. Differences in texture attributes are assessed by age at death (n=25 subadults; n=9 young adults; n=20 middle adults; n=4 old adults). Preliminary results indicate that differences between age groups do exist suggesting age graded change in dietary abrasiveness. The degree of variability between and within age groups in the sample highlights that population averaged interpretations of diet can mask important age-related differences in behaviour.

### Near-infrared Spectroscopy as a Tool for Modeling Savanna Primate Diets

ERIN K. SMITH<sup>1</sup>, JENNIFER LEICHLITER<sup>2</sup>, MATT SPONHEIMER<sup>3</sup> and THURE CERLING<sup>4</sup>

<sup>1</sup>Anthropology, University of Colorado, Boulder,

<sup>2</sup>Anthropology, University of Colorado, Boulder,

<sup>3</sup>Anthropology, University of Colorado, Boulder,

<sup>4</sup>Biology, University of Utah

Primatologists and behavioral ecologists have recently begun exploring how near-infrared spectroscopy (NIRS) can be useful in field and lab contexts. One benefit of NIRS is that, unlike spectroscopic and spectrometric technologies that require extensive sample preparation, NIRS requires little pre-analytical preparation. Additionally, some NIRS devices are portable and can produce spectra in seconds, further contributing to their utility in field research. Here, we use NIRS to study feces of savanna mammals with known diets and demonstrate that the spectra allow us to model monocot versus dicot consumption. We also explore the possibility

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that NIRS can provide more detailed information about an animal's diet including plant parts consumed. In certain cases, NIRS may allow us to forego costly and time-consuming laboratory methods and could allow us to study savanna primate diets at spatial and temporal scales that are otherwise impractical. We argue that NIRS technologies have the potential to transform field methods and might allow researchers to ask a host of new questions about their study organisms.

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### Little Green Men, Huge Angry People, and Across the Water Visits: Very Wrong Things People Say about Old Times in the New World

RICK W. A. SMITH<sup>1</sup> and JENNIFER A. RAFF<sup>2</sup>

<sup>1</sup>Anthropology, University of Texas at Austin,

<sup>2</sup>Anthropology, University of Kansas

From speculation about alien encounters to ancient transatlantic contact between the Old and New Worlds, popular conceptions of Native American history are replete with contemporary folklore that is endorsed by fringe science. These stories have contributed to widespread stereotypes and misunderstandings about Native Americans and their histories, and often act to dehumanize indigenous peoples and delegitimize their societies relative to those of Europeans. Because many of these stories are perpetuated through popular media channels, there is a pressing need for more effective public scientific communication about population histories in the Americas to dispel existing misconceptions. In this presentation, we will use the one thousand most common words in the English language to discuss some of the most prominent narratives about population history in the Americas for a public audience. In addition to considering ancient alien visits and transatlantic migrations, we will discuss common fallacies regarding the construction of monumental architecture and cultural practices of cranial modification. We will contrast these claims with the latest findings from archaeology, genetics, and paleogenetics, synthesizing these lines of evidence to provide an up to date and accessible scientific account of ancient population histories in the Americas.

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### Trace Element Studies Support Rapid Tooth Enamel Mineralization at the Enamel-Dentine Junction

TANYA M. SMITH<sup>1</sup>, CHRISTINE AUSTIN<sup>2</sup>, DANIEL GREEN<sup>1</sup> and MANISH ARORA<sup>2</sup>

<sup>1</sup>Department of Human Evolutionary Biology, Harvard University, <sup>2</sup>Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai

Understanding how elements are incorporated into tooth enamel during mineralization is critical for interpreting human diets, environments,

and migrations in the past. Previous studies of trace elements and isotopic variants have been hampered by incomplete knowledge of elemental incorporation, specifically about the potential delay between enamel secretion and the incorporation of biologically relevant elements during enamel maturation. Radiographic and large-scale sampling approaches suggest that the majority of mineral incorporation is delayed by several months in mammalian teeth, leading to substantial time averaging in samples. Here we report the results of laser ablation studies of trace elements in humans, macaques, and sheep of known birth and dietary histories. We do not find a marked delay of barium or strontium incorporation near the enamel-dentine junction. Elemental profiles from enamel are similar to those of rapidly mineralizing dentine, although the absolute values differ. Moreover, elemental maps reveal dietary transitions close to the neonatal line, demonstrating that the consumption of milk can be identified without a marked temporal delay. Patterns of trace element and oxygen isotope incorporation reveal subsequent waves of mineralization in mid-thickness enamel and potential post-eruptive changes in subsurface enamel. We suggest that laser ablation and ion beam sampling approaches attempting to relate tooth chemistry to the incremental growth patterns of mammalian teeth will be most effective when the innermost enamel layer is sampled.

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### The case of a primary malignant bone tumor in a pre-Columbian skeleton from Cerro Brujo, Bocas del Toro, Panamá

NICOLE E. SMITH-GUZMÁN<sup>1</sup>, JEFFREY A. TORETSKY<sup>2</sup> and RICHARD G. COOKE<sup>1</sup>

<sup>1</sup>Center for Tropical Paleocology and Archaeology, Smithsonian Tropical Research Institute,

<sup>2</sup>Departments of Oncology and Pediatrics, Georgetown University

Compared to other maladies, cancer in ancient humans seldom appears in the paleopathological literature, due in part to the difficulty in identifying cancer from its often non-specific inflammatory skeletal manifestation. Most ancient skeletons afflicted with cancer display lesions of metastatic cancer, originating outside of the skeleton itself. Here we present a rare case of primary bone cancer principally affecting the right humerus of a skeleton from the site of Cerro Brujo (900-1100 CE) in Bocas del Toro, Panamá, excavated in the early 1970s. The humerus contains a dense, calcified sclerotic mass with associated lytic lesions localized around the midshaft of the diaphysis. Evidence of systemic inflammation and anemia, likely caused by the cancer, are

visible in the form of bilateral periosteal reactions on the tibiae and severe porotic hyperostosis of the cranial vault. Through differential diagnosis, it was determined that the tumor is consistent with either osteosarcoma or Ewing's sarcoma based on the radiographic appearance, the location of the tumor, and the age of the individual. The radiocarbon date associated with this individual (1265-1380 CE) places her 150 years later than the site's occupation. This later date, combined with the fact that this was the only burial discovered at the site and contained an individual with such a visible, painful, and rare pathological condition, suggests that this was likely a ritual burial.

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### Mouths to Feed: Subsistence Transition and Childhood Health in the Ancient Atacama Desert, Northern Chile (ca 5,500 – 1,500 BP)

ANNE MARIE E. SOHLER-SNODDY<sup>1</sup>, SIÂN E. HALCROW<sup>1</sup>, HALLIE R. BUCKLEY<sup>1</sup>, VIVIAN STANDEN<sup>2</sup> and BERNARDO ARRIAZA<sup>3</sup>

<sup>1</sup>Anatomy, University of Otago, <sup>2</sup>Departamento de Antropología and Museo San Miguel de Azapa, Universidad de Tarapacá, <sup>3</sup>Instituto de Alta Investigación, Universidad de Tarapacá

Beginning in 3,500 BP the people of the Atacama Desert of Northern Chile began to shift away from a maritime-based hunter-gatherer economy towards a maize-based agropastoral economy. It has been argued that the agricultural transition in many regions was accompanied by a general decline in human health as represented by an increase in skeletal indicators of physiological stress, infectious disease, and nutritional deficiencies. Children are particularly vulnerable to nutritional deficiencies and are thus an excellent proxy for evaluating population level nutritional status. We hypothesize that the adoption of agriculture in the Atacama resulted in an overall increase in micronutrient malnutrition disorders in the form of scurvy (vitamin C deficiency) and iron deficiency anemia in children (0-15 years). Skeletal individuals from the pre-agricultural Archaic Period ( $N = 18$ ; ca 5,500 – 3,500 BP) and the early agricultural Formative Period ( $N = 64$ ; ca 3,500-1,500 BP) underwent macroscopic and radiographic paleopathological analysis. No significant difference was found in the point prevalence of probable cases of scurvy ( $X^2 = 0.0898$ ,  $P = 0.764$ ) or iron deficiency anemia (Fisher's exact,  $P = 0.511$ ) between these periods. We discuss these results in light of what is known about exploited natural resources and cultivated domesticates during the Formative Period and argue that biosocial adaptations to the unique environment of the Atacama may present a challenge to the widely accepted paradigm of a negative impact of the adoption of agricultural on nutritional status. However, additional work

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with a larger Archaic Period cohort is needed to strengthen this argument.

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### Environmental background for a catastrophic event in an early urban centre in Syria: the evidence from oxygen isotopes and enamel defects

ARKADIUSZ SOŁTYSIAK<sup>1</sup>, CARSTEN WITZEL<sup>2</sup>, HOLGER SCHUTKOWSKI<sup>3</sup>, EWA KRZEMIŃSKA<sup>4</sup> and ZBIGNIEW CZUPYT<sup>4</sup>

<sup>1</sup>Department of Bioarchaeology, University of Warsaw, Poland, <sup>2</sup>Institute of Biology and Chemistry, University of Hildesheim, Germany, <sup>3</sup>Department of Archaeology, Anthropology and Forensic Science, Bournemouth University, UK, <sup>4</sup>Micro-area Analysis Laboratory, Polish Geological Institute - National Research Institute, Poland

Several mass burials of human remains were found in a midden near Tell Brak, a major urban centre of the Late Chalcolithic in Syria. The oldest of them (EM loc. 6, 3750-3500 cal. BC) contained disarticulated and scavenged bones of mainly females, children and adolescents (MNI=80) and the context together with age-at-death profile suggests a catastrophic event. To check whether this event could have been related to prolonged drought and to crop failure, we have measured oxygen isotopic values ( $\delta^{18}\text{O}$ , VSMOW) in enamel of three permanent canine crowns representing different subadult individuals who died during the event. To secure maximum temporal resolution, measurements were taken in series of 80 to 100 spots along dentin-enamel junction using sensitive high-resolution ion microprobe (SHRIMP IIe/MC). Additionally, the sequence of dental micro- and macrodefects was obtained for the same teeth. The teeth represented children with estimated age-at-death of c. 2500-2700 days. In all three crowns, a serious long-lasting enamel defect occurred c. 1100-1500 days before death of these individuals and roughly in the same time the  $\delta^{18}\text{O}$  values rose from the range c. 16-20‰ to the range c. 18-22‰. In spite of some inter-individual differences, this coupling of enamel defects and shift in oxygen isotopic values is relatively clear in all three individuals and it may indicate an episode of high environmental stress level that started 3-4 years before their death.

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### From Foundational Concepts to Critical Reflection: Building Student Understanding in Introductory Courses

ELIZABETH SOLURI

Department of Anthropology, Cabrillo College

Previous research suggests active and cooperative pedagogies that build student understanding from foundational knowledge to higher critical thinking are effective in introductory biological anthropology courses. However, this research does not clearly differentiate between the effects of active and cooperative learning tasks and the effect of the general structure and organization of these tasks as a means for constructing student understanding. The present research addresses this issue by specifically considering the impact of a more structured pedagogy that uses multiple home-based and in-class activities to progressively build student understanding over time. I compare a control group of students (2 class sections,  $n = 51$ ), taught with traditional techniques, to 4 class sections of students ( $n = 124$ ) taught using the more structured approach. Both teaching contexts employed similar learning tasks and were taught by the same instructor. Effectiveness of the constructed pedagogy is evaluated in three course content areas: genetics and evolutionary theory, primatology, and paleo-anthropology. Using between-subjects T-tests, comparing the two student groups on these three content areas, I detect statistically significant differences when comparing the control group ( $M = 76.63$ ,  $SD = 14.96$ ) with the structured group ( $M = 84.87$ ,  $SD = 11.29$ ,  $p = 0.0007$ ) in the paleo-anthropology content area. This preliminary study suggests the constructed pedagogy is better than traditional techniques for teaching paleo-anthropology material. Further research is needed to determine what effect a modified version of this pedagogy may have on improving student learning in genetics and evolutionary theory and primatology content areas.

### Mechanisms of convergent testis transcriptome evolution in primates

EKIN SAGLICAN<sup>1</sup>, MELIKE DONERTAS<sup>1</sup>, RORI ROHLFS<sup>2</sup>, EZGI OZKURT<sup>1,4</sup>, HAIYANG HU<sup>3</sup>, RAFIK NEME<sup>4,5</sup>, BABUR ERDEM<sup>1</sup>, PHILIPP KHAITOVICH<sup>3</sup> and MEHMET SOMEL<sup>1</sup>

<sup>1</sup>Biological Sciences, Middle East Technical University, <sup>2</sup>Cell and Molecular Biology, San Francisco State University, <sup>3</sup>Comparative Biology, CAS-MPG Partner Institute for Computational Biology, <sup>4</sup>Evolutionary Genetics, Max Planck Institute for Evolutionary Biology, <sup>5</sup>Biochemistry and Molecular Biophysics, Columbia University Medical Center

Testis size is a prime example of convergent evolution under different mating strategies among primates: polyandrous or polygynandrous species (multi-male) tend to have higher testis/body ratios than polygynous or monogamous species (single-male). It was proposed that primate testis transcriptome evolution may also be driven by mating-type, but the idea has not yet been tested. Here, we combined published and novel transcriptome datasets to study convergent evolution of testis gene expression levels in primates (gorilla, human, chimpanzee, bonobo,

rhesus macaque, common marmoset) and rodents (house mouse, steppe mouse, brown rat), and to investigate possible mechanisms underlying the evolution of testis gene expression. Applying an Ornstein-Uhlenbeck-based model to testis transcriptomes, we found that thousands of genes' expression levels reflect species' mating type, instead of their phylogeny. Such convergent evolution signal was not found in brain transcriptomes of the same species. Notably, this mating type effect on testis gene expression was mainly driven by convergent tissue composition differences, with multi-male species having higher estimates of germ-line proportion in their testes. Finally, through comparison with testis development series, we showed that single-male species' testes retain juvenile characteristics in gene expression and predicted tissue composition, compared to those of multi-male species. Our results indicate that rapid convergent evolution in testis size and transcriptome profiles may be achieved through simple developmental shifts. Our approach further provides a baseline for determining cell-autonomous convergent evolution driven by sexual selection in primates.

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### Porotic hyperostosis versus cribra orbitalia for prehistoric populations from the southeastern United States: contributions to the etiology debate

TESSA SOMOGYI and ELIZABETH A. DIGANGI

Anthropology, Binghamton University

Bioarchaeology has recently been refocused on developing a greater understanding of skeletal markers of stress, which are often utilized in interpretations of health or stress patterns for past populations. The purpose of this project is to critically evaluate the relationship between cribra orbitalia and porotic hyperostosis with a focus on the etiology of these lesions. Data were gathered from 472 individuals from the Tennessee Valley Authority skeletal collection curated at the McClung Museum of Natural History and Culture at the University of Tennessee, Knoxville. These individuals represent several time periods of the Southeast: the Archaic (800-1000 B.C.), Woodland (1000 B.C.- A.D. 1000), and Mississippian (A.D. 1000-1600). Chi-square tests and crosstabulations were calculated using SPSS and revealed that cribra orbitalia and porotic hyperostosis occur at significantly different rates in the sample (chi-square,  $p=0.00$ ). Porotic hyperostosis occurring independently of cribra orbitalia ( $n=76$ ) was found to be more common than cribra orbitalia occurring independently ( $n=37$ ). However, many individuals did possess both lesions ( $n=89$ ). These results indicate that although cribra

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orbitalia and porotic hyperostosis do tend to occur together on the same individual, they also occur independently of one another at a significant rate. It is clear that these stress markers are not as closely related as previously thought, and iron deficiency anemia may not be the main etiologic factor. Discussion of these results will explore the potential of the megaloblastic anemia hypothesis and its relationship to the formation of these stress markers.

### Behavioral and Fecal Hormonal Variation in Vervet Monkeys (*Chlorocebus pygerythrus*) in South African Rehabilitation Centers

AURIANA I. GILLILAND-LLOYD, MARY C. SORRENTI and TRUDY R. TURNER

Anthropology, University of Wisconsin Milwaukee

Vervet monkeys (*Chlorocebus pygerythrus*) are ubiquitous to southern Africa and are one of the most common animals found in wildlife sanctuaries in South Africa. With few regulations guiding South African primate rehabilitation, best practices for rehabilitation and release are an ongoing debate. This study observed vervet monkey behavior and hormonal variation in two centers in South Africa to determine whether stress and associated behaviors vary by sex, and between differing stages of rehabilitation. This study also discussed whether differences in behavior and glucocorticoid response among rehabilitant vervet monkeys could be influenced by location, environment, or logistical differences. The Riverside Wildlife Rehabilitation Centre utilizes open-air, fenced in acreage with natural foliage to acclimate primates to their typical environment. The Bamblela Wildlife Sanctuary uses fenced-in enclosures and releases animals directly from their enclosure. Both sites operate with variations in the following stages of rehabilitation: quarantine, introduction, and semi-wild. Over 140 hours of behavioral observation and 200 fecal samples were collected. Females exhibited higher rates of affiliative and agonistic behavior over males. Despite males in the early process of rehabilitation having slightly higher cortisol rates, no significant difference was found in glucocorticoid expression among groups. Correlation analysis shows that agonistic behaviors are positively related to cortisol concentration and act as predictors for a physiological stress response. No other variables interacted significantly with cortisol concentration. Findings suggest that rehabilitant vervets show stress patterns typically seen in wild vervets and that female vervets experience heightened levels of behavioral variation throughout the rehabilitation process.

### Exploring morphological shape variation in modern human tali

RITA SORRENTINO<sup>1,2</sup>, CATERINA MINGHETTI<sup>2</sup>, WILLIAM PARR<sup>3</sup>, KEVIN TURLEY<sup>4</sup>, STEPHEN WROE<sup>5</sup>, COLIN SHAW<sup>6</sup>, JAAP SAERS<sup>6</sup>, ANNE SU<sup>7</sup>, LUCA FIORENZA<sup>8</sup>, FRANCESCO FELETTI<sup>9</sup>, STEPHEN FROST<sup>4</sup>, KRISTIAN J. CARLSON<sup>10,11</sup>, MARIA G. BELCASTRO<sup>1</sup>, TIM RYAN<sup>12</sup> and STEFANO BENAZZI<sup>13,2</sup>

<sup>1</sup>Department of Biological, Geological and Environmental Sciences, University of Bologna,

<sup>2</sup>Department of Cultural Heritage, University of Bologna, <sup>3</sup>Surgical and Orthopaedic Research Laboratory, Prince of Wales Hospital, University of New South Wales, <sup>4</sup>Department of Anthropology, University of Oregon, <sup>5</sup>Computational Biomechanics Research Group, Zoology Division, School of Environmental and Rural Science, University of New England, <sup>6</sup>PAVE Research Group, Department of Archaeology & Anthropology, University of Cambridge, <sup>7</sup>School of Health Sciences, Cleveland State University, <sup>8</sup>Department of Anatomy and Developmental Biology, Monash University, <sup>9</sup>Local Health Trust of Romagna, Department of Diagnostic Imaging, S.Maria delle Croci Hospital of Ravenna, <sup>10</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California, <sup>11</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>12</sup>Department of Anthropology and Center for Quantitative Imaging, Pennsylvania State University, <sup>13</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Recent contributions have employed digital methods to investigate shape variation in hominoid tali. However, little of this work has assessed talar morphology within modern humans.

Here we apply (semi)landmark based method to assess talar morphological differences between groups of modern human living in different terrain.

A template of 251 (semi)landmarks was digitized on 3D digital models of 88 modern human tali: 26 hunter-gatherers, 15 mountain dwellers and 47 farmers occupying relative flat terrain. Models were Procrustes superimposed and Principal Component (PC) analysis was used to explore observed morphological variation. We also computed degree of morphological integration between trochlear, subtalar joint and talar head articular surfaces using two-block partial least squares (PLS).

The first three PCs describe 33.3% of morphological variation in the sample. Even though most specimens overlap in the PCA plot, clustering of hunter-gatherers and the other groups tend to separate on PC1 (18.8%). Negative scores (hunter-gatherers) reflect mediolaterally wider and dorsoplantarily compressed corpora, as well as enlarged necks and talar heads. Positive scores reflect more cuboidal corpora, less posteriorly extended flexor hallucis longus grooves, reduced anterior extension of trochleae, and smaller talar heads. No significant differences were found

through PLS analysis, suggesting that different talar regions are not tightly integrated.

Overall, the talus seems promising for informing our understanding of terrain use among modern humans. These results could have important implications for the interpretation of fossil specimens and the likely landscapes they occupied. Future studies could increase the sample size to test the effects of subsistence economy.

### An analysis of infant bone composition using Raman Spectroscopy

MIRIAM E. SOTO MARTINEZ<sup>1</sup>, CHRISTIAN M. CROWDER<sup>1</sup> and XIAOHONG BI<sup>2</sup>

<sup>1</sup>Forensic Anthropology Division, Harris County Institute of Forensic Sciences, <sup>2</sup>Center for Proteomics and Systems Biology, The University of Texas Health and Science Center at Houston

From a broad perspective, bone's ability to resist fracture can be compromised by either a reduction in bone quantity or quality with the latter occurring through changes in the material composition. While bone quantity in the developing skeleton is somewhat better understood, limited research has examined age-related compositional changes during infancy. This study's purpose is to investigate such alterations in infant cortical bone and provide a better understanding of infant bone quality.

Sternal end rib cross-sections were obtained from 32 infants (0-10 months of age). Raman spectroscopy was used to measure the molecular constituents of bone mineral and organic matrix from the pleural periosteal surface at the midpoint of the rib samples. Raman-derived bone quality indicators were calculated, including mineral-to-collagen ratio, mineral crystallinity, hydroxyapatite carbonation, collagen content, and collagen cross-linking. ANOVA and simple linear regressions were conducted using age as the independent variable and Raman parameters as the dependent variables. Age was significantly associated with collagen content ( $R^2 = .16$ ,  $F(1, 30) = 5.53$ ,  $p = .025$ ) and mineral crystallinity ( $R^2 = .15$ ,  $F(1, 30) = 5.33$ ,  $p = .028$ ), which contribute to bone ductility and bone strength respectively. Regression coefficients indicated that as age increased, collagen content ( $\beta = .005$ ,  $p = .025$ ) and mineral crystallinity ( $\beta = .013$ ,  $p = .028$ ) increased. Mineral-to-collagen ratio, carbonation, and collagen cross-linking showed no association with age, possibly indicating a complex relationship with growth and development. These findings are important for the future establishment of a normality baseline which is needed to assess bone fragility and fracture susceptibility.

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### A Comparative Growth Analysis of African Child Slaves in 15<sup>th</sup> to 17<sup>th</sup> Century Portugal

LAURE SPAKE<sup>1</sup>, MARIA TERESA FERREIRA<sup>2</sup>, HUGO F.V. CARDOSO<sup>1</sup> and SOFIA WASTERLAIN<sup>2</sup>

<sup>1</sup>Archaeology, Simon Fraser University, <sup>2</sup>Life Sciences, University of Coimbra

A recent archaeological excavation in Lagos, Portugal, revealed various skeletal remains belonging to slaves captured in Africa by the Portuguese between the 15th and 17th centuries. As Lagos was one of earliest hubs of the African slave trade, these burials represent the earliest evidence of forced migration in bondage from Africa to Europe. A significant number of juvenile remains were excavated, which provides a unique opportunity to look at the lives of the earliest African enslaved children. As a measure of health status and general well-being, long bone length for age in the Lagos child sample (n=23) was compared to known age samples of juvenile individuals from Africa, Europe and North-America. Results suggest that Lagos children were significantly stunted and were of similar size for age compared to Africans and African-Americans in the early 20th century, who suffered racial discrimination and were exposed to multiple types of violence, including abuse, excessive workloads, malnutrition and poor living conditions. Although the Lagos sample is geographic diverse and may represent either recent forced migration or slaves born in Portugal, their skeletal remains provide invaluable insights into the hardships of child slaves' lives.

### Late Upper Paleolithic funerary behavior at Arene Candide Cave (Finale Ligure, Italy)

VITALE S. SPARACELLO<sup>1,2</sup>, STEFANO ROSSI<sup>3,4</sup>, PAUL PETTIT<sup>5</sup>, CHARLOTTE A. ROBERTS<sup>2</sup>, JULIEN RIEL-SALVATORE<sup>5</sup> and VINCENZO FORMICOLA<sup>6</sup>

<sup>1</sup>UMR 5199 PACEA, Univ. Bordeaux, <sup>2</sup>Archaeology, Durham University, <sup>3</sup>Belle Arti e Paesaggio per la città metropolitana di Genova e le province di Imperia, La Spezia e Savona, Soprintendenza Archeologia, <sup>4</sup>DISTAV, Università di Genova, <sup>5</sup>Anthropology, Université de Montréal, <sup>6</sup>Biology, Università di Pisa

The Pleistocene layers of the Arene Candide cave yielded in 1940-41 one of the most important Late Upper Paleolithic (Final Epigravettian) skeletal series. It consists of ten primary burials and six clusters of bones in secondary deposition, apparently accumulated during two distinct phases separated by a few centuries (AMS dates spanning 12,028 – 11,181 and 12,816 – 12,421 cal BP at 2σ). We gained new insights on funerary behavior through the osteological and spatial analysis of the burials and human bone accumulations found in the cave. The secondary burials have traditionally been interpreted as older burials that were disturbed to make space for new inhumations. Our results suggest that those disturbances were not casual: in both

phases of funerary use of the site, older burials were intentionally displaced to bury later inhumations, forming the clusters of secondary deposits. Then, some skeletal elements, especially crania, were removed from clusters and re-arranged around the new burials; these were often placed within stone niches. Strikingly, two individuals put together through this behavior show pathological changes suggestive of hereditary rickets. It should be noted that finding (probably) congenital bone dysplasias is not infrequent in Gravettian and Epigravettian burials. Our observations suggest that the five Phase II individuals were buried, possibly by the same group, over a relatively brief time span. Similar behaviors were observed in both phases of mortuary use of the cave, indicating a persistence in Final Epigravettian funerary models despite their archaeologically apparent rarity and intermittent nature.

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### Subsistence and mobility at Hellenistic New Halos, Greece: as reconstructed from stable carbon, nitrogen, oxygen and strontium isotope analysis

HILLARY A. SPARKES<sup>1</sup>, SANDRA GARVIE-LOK<sup>1</sup> and MARGRIET HAAGSMA<sup>2</sup>

<sup>1</sup>Anthropology, University of Alberta, <sup>2</sup>History and Classics, University of Alberta

The city of New Halos in Thessaly, Greece was re-founded around 302 BC and was occupied for only a few decades, making it ideal for study because it represents a snapshot of life in a Hellenistic polis. This study investigated dietary habits using stable carbon and nitrogen isotopes, testing the hypothesis that marine resources contributed significantly to the diet because a large amount of marine shells were recovered during excavation. A second thread of investigation used stable strontium and oxygen isotopes to examine migration patterns and population composition. New Halos, like many Hellenistic cities, was a new settlement likely founded on royal orders, and it was speculated that many individuals might be non-local to the area.

Skeletal remains from 98 individuals were collected for stable isotope analysis. Bone collagen results indicate that most inhabitants of New Halos consumed a C<sub>3</sub> terrestrial diet. Some individuals show signs of marine input, but this was not a dietary resource heavily used by the entire population. Other individuals appear to have consumed a low protein diet depending heavily on C<sub>3</sub> grains and olive oil.

The strontium and oxygen values of enamel suggest that the population of New Halos was a mixture of both locally born and non-local individuals. It appears that the majority of non-local

individuals grew up in areas to the west of New Halos. Using four different isotopes to investigate diet and mobility has provided exciting information about the Hellenistic population of New Halos, demonstrating the utility of multi-isotope studies in bioarchaeology.

### Risk sensitive fertility behavior in historic Orkney, Scotland

COREY S. SPARKS

Department of Demography, The University of Texas at San Antonio

When demographers discuss the limitation of fertility, they typically are referring to the conscious decision making process undertaken by a couple that decides their fertility preferences. Because of the lack of contextual information on contraceptive availability and effectiveness, the actual "control" over fertility in historic and anthropological populations has been a difficult premise to substantiate. The variance compensation hypothesis states that a couple should decide on a large enough completed family size to compensate for the probability that some of their offspring will not survive to adulthood. This paper focuses on the risk-sensitive nature of fertility behavior as manifested by individual, household and community level influences on birth spacing, and tests the idea of risk sensitivity in patterns of childbirth using discrete time frailty models to on birth histories of married couples between 1855 and 1905 in Orkney, Scotland, as well as several measures of local-scale population characteristics to investigate if the timing of births displays a sensitivity to local contextual variables that may influence couples' decisions to have another child. Results indicate that there is significant influence of local population density on the risk of having a first birth. While for higher order births, timing is significantly influenced by a variety of labor force, population density and recent patterns of infant mortality. This suggests that, despite the presence of modern contraceptive techniques in this population, exogenous effects do play a role in the timing of births.

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### Can the Timing of Deciduous Tooth Emergence be Partially Accounted for by Mother's Past or Current Circumstances?

JENNIFER E. SPENCE<sup>1</sup>, BRUCE FLOYD<sup>2</sup>, DEBBIE GUATELLI-STEINBERG<sup>3</sup> and BARBARA PIPERATA<sup>3</sup>

<sup>1</sup>Anthropology, Pacific Lutheran University,

<sup>2</sup>Anthropology, University of Auckland, <sup>3</sup>Anthropology, Ohio State University

In this study, we evaluated the relationship between maternal anthropometry and emergence timing of the first deciduous tooth. We hypothesized that variation in earlier developmental environments (as marked by maternal height and

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age at menarche) and later circumstances (as marked by weight gain during pregnancy) should significantly correlate with the timing of deciduous tooth emergence. Because several studies indicate that taller women are more sensitive to nutritional supplementation and have larger babies, we hypothesized that taller mothers and those who gained more weight during pregnancy would give birth to infants whose deciduous teeth emerged earlier. Infants of mothers who reached menarche more rapidly were also anticipated to have earlier emerging teeth, if menarche indicates genetically influenced maturational tempo and/or better circumstances at an early age. We used survival analysis as implemented in SYSTAT 10 because the criterion variable (number of days from conception/birth to emergence of the first deciduous tooth) was interval censored within similar but unequal intervals. A Weibull model was selected because the conditional probability that an infant's first deciduous tooth will emerge increases with time. For 82 mother-infant pairs, emergence timing was significantly inversely associated with mothers' heights ( $P = 0.028$ ), while menarche was weakly positively associated ( $P = 0.099$ ). Cumulative adjusted weight gain during pregnancy was also inversely associated with emergence timing ( $P = 0.025$ ), but only if cumulative gains in mid-upper arm circumference were also included in the model. Pregnancy duration was included as a covariate initially but did not influence the relationships reported.

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### Quantifying Countershading in *Eulemur* Using Eigencoats

AMANDA N. SPRIGGS<sup>1,2</sup>, BRENDA J. BRADLEY<sup>2</sup>, JASON M. KAMILAR<sup>3,4</sup> and ADAM D. GORDON<sup>1</sup>

<sup>1</sup>Anthropology, University at Albany-SUNY,

<sup>2</sup>The Center for the Advanced Study of Human Paleobiology (CASHP), Department of Anthropology, The George Washington University, <sup>3</sup>Department of Anthropology, University of Massachusetts Amherst, <sup>4</sup>Graduate Program in Organismic and Evolutionary Biology, University of Massachusetts Amherst

Countershading has been identified as an important anti-predator adaptation, especially within Primates. Smaller-bodied primates that adopt a pronograde posture and locomotion are more likely to be countershaded compared to larger-bodied primates that move and feed using an orthograde posture. Many *Eulemur* individuals have countershaded pelage, although the degree of countershading and difference in countershading between sexes varies among *Eulemur* species. Here we use the eigencoats algorithm, a variation of eigenfaces, to quantify countershading on the dorsal and ventral surfaces of the entire pelage for 39 adult male and female

*Eulemur* ( $n=78$  surfaces). An eigencoat analysis takes entire coat variation into consideration by transforming color-corrected digital photographs of preserved primate skins into column vectors of pixel data, then performing a principal component analysis on the covariance matrix of these vectors. The first principal component accounted for 60% of the total variance and captured variation relating to darker or lighter pelage coloration across an entire dorsal or ventral surface, with a clear division between darker dorsal and lighter ventral surfaces. Degree of countershading was quantified by calculating the Euclidean distance of principal component scores between dorsal and ventral surfaces of each specimen. Male *E. albigrons* had the highest countershading values (0.23, 0.21, and 0.19), while dorsal and ventral surfaces of male *E. macaco* had the lowest countershading values with little difference in color pattern between dorsal and ventral surfaces (0.032, 0.04, 0.02, and 0.03). This type of analysis can be generalized to other questions regarding pelage pattern variation in primates.

### Investigating the Genetic Impacts of Spanish missionization on the Guale of St. Catherines Island, Georgia

LAUREN C. SPRINGS<sup>1</sup>, CLARK S. LARSEN<sup>2</sup>, DAVID H. THOMAS<sup>3</sup>, ANNA M. SEMON<sup>3,4</sup> and DEBORAH A. BOLNICK<sup>1,5</sup>

<sup>1</sup>Anthropology, The University of Texas at Austin, <sup>2</sup>Anthropology, The Ohio State University,

<sup>3</sup>Anthropology, American Museum of Natural History, <sup>4</sup>Anthropology, University of North Carolina at Chapel Hill, <sup>5</sup>Population Research Center, The University of Texas at Austin

While it is known that European colonization of the Americas drastically reshaped indigenous landscapes, the genetic consequences of specific colonial practices are less well understood. For example, Spanish colonizing strategies in the Southeastern United States relied heavily on mission systems to assimilate and transform existing Native American cultural groups into a productive Spanish work force via forced reductions. These reducciones frequently shifted settlement patterns, merging native societies that had previously been distinct and dispersed social entities into a single, centralized community. The Guale of St. Catherines Island on the Georgia coast were subject to intensive Spanish missionization during the colonial period, and archaeological excavations at the Guale sites of Fallen Tree and Santa Catalina de Guale have documented the changing organization of the island inhabitants during missionization.

In this study, we present new mitogenome data from two burial populations to assess whether colonial reducción practices reshaped indigenous genetic diversity patterns on St. Catherines Island. We extracted ancient DNA from 50 individuals from the pre-mission Fallen Tree and

Spanish Mission Santa Catalina de Guale sites, and analyzed their genetic sequences to assess population changes over time. We analyzed networks of matrilineal lineage sharing, principal component analysis results, and indices of molecular diversity to characterize genetic variation in the Guale of St. Catherines Island and assess relatedness between the Fallen Tree and Santa Catalina populations. By comparing the pre-mission and mission populations, we are better able to elucidate the effects of missionization and reducción on genetic population structure.

This research was funded by The St. Catherines Island and Edward John Noble Foundations and the National Science Foundation.

### Ancient *Yersinia pestis* genomes provide novel insights into the phylogeographic history of Plague

MARIA A. SPYROU<sup>1</sup>, REZEDA I. TUKHATOVA<sup>2,3</sup>, MICHAL FELDMAN<sup>1</sup>, ALEXANDER HERBIG<sup>1</sup>, KIRSTEN I. BOS<sup>1</sup> and JOHANNES KRAUSE<sup>1,4</sup>

<sup>1</sup>Department of Archaeogenetics, Max Planck Institute for the Science of Human History, Germany,

<sup>2</sup>Laboratory of Paleoanthropology & Paleogenetics, Kazan Federal University, Russia, <sup>3</sup>Institute of Archaeology named after A. Kh. Khalikov, Tatarstan Academy of Sciences, Russia, <sup>4</sup>Department of Archeological Sciences, University of Tuebingen, Germany

Plague has been one of the most feared diseases among humans. Genetic data indicate its presence in Eurasia since the Bronze Age. The causative agent, *Yersinia pestis*, is known to be responsible for at least three historical pandemics, namely the Plague of Justinian that occurred between the 6<sup>th</sup> and 8<sup>th</sup> centuries AD; the second plague pandemic that began with the infamous Black Death, and lasted between the 14<sup>th</sup> and 18<sup>th</sup> centuries AD; and the third plague pandemic (late 19<sup>th</sup> -20<sup>th</sup> century), which began in China and achieved a near worldwide spread. Although plague is not currently considered as a pandemic threat, the reconstruction of its genetic history may potentially be informative as a model for infectious disease epidemiology and surveillance. The advent of next generation sequencing (NGS) technology has enabled the reconstruction of whole *Y. pestis* genomes from victims of historical outbreaks of plague, and comparisons to extant lineages present around the world. These comparative genomic studies have suggested the presence of a plague focus in Europe during the second plague pandemic and have proposed a genetic link between the European Black Death and the third plague pandemic. The geographic distribution of the proposed European plague reservoir and the reasons for its disappearance in the 18<sup>th</sup> century are still, however, unclear. Here, we address outstanding questions in plague research by discussing current evidence along with new genomic data from the second plague pandemic.

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## **FOXP2 Variation in Great Ape Populations offers potential Insights into Variation in Communication**

NICKY STAES<sup>1</sup>, CHESTER C. SHERWOOD<sup>1</sup>, MARC DM. MONTERO<sup>2</sup>, JOHN J. ELY<sup>3</sup>, WILLIAM D. HOPKINS<sup>4,5</sup> and BRENDA J. BRADLEY<sup>1</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, George Washington University, <sup>2</sup>Institut de Biologia Evolutiva, Universitat Pompeu Fabra, <sup>3</sup>MAEBIOS, UTMD Anderson ME Keeling Center for Comparative Medicine, <sup>4</sup>Neuroscience Institute and Language Research Center, Georgia State University, <sup>5</sup>Division of Developmental and Cognitive Neuroscience, Yerkes National Primate Research Center

The gene coding for forkhead box protein P2 (*FOXP2*) is the first gene discovered to be associated with human language disorders and fine control language production. Its evolution has been hypothesized as an important factor in the origins of human speech and language. The protein coding sequence is highly conserved across mammals, with some notable exceptions, particularly in echolocating bats. Humans differ in only two functional amino acid substitutions from chimpanzees, bonobos and gorillas, with an additional fixed substitution found in orangutans. However, no study to date has examined the degree of natural polymorphism in large samples of unrelated great apes. In this study, we analyzed DNA sequence data from 63 chimpanzees, 11 bonobos, 48 gorillas and 28 orangutans. Results confirm the previously reported interspecies differences in functional coding sequence between humans and great apes. However, inspection of within-species coding sequence reveals two additional nonsynonymous SNPs. In gorillas, a G/T SNP in exon 7 leads to an Alanine to Serine substitution. In orangutans, a C/A SNP in exon 16 leads to a Proline to Threonine substitution. The latter SNP is found only in Sumatran orangutans, with the ancestral allele present at higher frequency (0.71). Allele and genotype frequencies were in Hardy Weinberg equilibrium ( $\chi^2 = 2.20$ ,  $df = 1$ ,  $p = 0.138$ ). As *FOXP2* has been linked to vocal learning and vocalization frequency in a variety of species, this SNP may be linked to reported differences between orangutan populations in vocal repertoire and peak frequency.

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## **Assembling a Winning Army: Strontium Isotope Analysis of Local and Non-Local Soldiers from the Ancient Greek Battles of Himera (480 BCE, 409 BCE)**

JULIANNE R. STAMER<sup>1</sup>, KATHERINE L. REINBERGER<sup>2</sup>, BRITNEY KYLE<sup>3</sup>, PIER FRANCESCO FABBRI<sup>4</sup>, STEFANO VASSALLO<sup>5</sup> and LAURIE J. REITSEMA<sup>2</sup>

<sup>1</sup>Anthropology, The Ohio State University, Columbus, Ohio, 43210, <sup>2</sup>Anthropology, University of Georgia, Athens, GA, 30605, <sup>3</sup>Anthropology, University of

Northern Colorado, Greeley, CO, <sup>4</sup>Beni Culturali, Università del Salento, Lecce, Italy, 73100, <sup>5</sup>Regional Archaeological Superintendence of Palermo, Italy

Herodotus writes of two ancient battles fought at the Greek colony of Himera in Sicily between Greek and Carthaginian forces. The Battle of 480 BCE was won by the Greeks, who prepared in advance by assembling a coalition of allied and mercenary soldiers from other regions. The Battle of 409 BCE was lost by the Greeks, who had little time to prepare and relied on citizen soldiers to defend the city. Himera was destroyed and abandoned after the Battle of 409 BCE.

We analyze strontium isotope ratios of human tooth enamel from 26 individuals recovered from mass graves associated with the two battles, to distinguish "local" soldiers from "non-locals" and compare them across battle contexts. We compare human values to those of three faunal enamel specimens (pig, horse, and dog) representing baseline <sup>87</sup>Sr/<sup>86</sup>Sr values for Himera. Non-local humans are designated as those whose <sup>87</sup>Sr/<sup>86</sup>Sr ratios are outside one standard deviation of the mean of the faunal baseline.

Results show more non-local soldiers in the 480 BCE mass graves (n=14; 70%) than in the 409 BCE mass graves (n=2; 33%), supporting historical accounts that soldiers from mainland Greece, elsewhere on Sicily, and possibly other Mediterranean regions, bolstered the army in 480 BCE and contributed to a Greek victory. Lacking support from other Greek cities and allies, Himerans lost the Battle of 409 BCE. These data show how a postcolonial sense of shared Greek identity could help support and sustain colonies distributed throughout the ancient Mediterranean, even generations after their foundations.

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## **Femoral metaphyseal morphology as a predictor of locomotor behavior**

PETER A. STAMOS<sup>1</sup>, ZERESEY ALEMSEGED<sup>2</sup>, ABHIJIT J. CHAUDHARI<sup>3</sup> and TIMOTHY D. WEAVER<sup>1</sup>

<sup>1</sup>Anthropology, University of California Davis, <sup>2</sup>Organismal Biology and Anatomy, University of Chicago, <sup>3</sup>Radiology, University of California Davis School of Medicine

Preuschoft and Tardieu (1996) observed differences between juvenile chimpanzees and humans in the morphology of the metaphyseal surface of the distal femur. While this surface is relatively flat in humans, it is characterized by significant topographic complexity in chimpanzees. This morphology was argued to provide a locking mechanism to protect the growth plate and prevent shearing of the epiphysis from the

metaphysis during the flexed-knee climbing and knuckle-walking of chimpanzees.

These shape differences in metaphyseal surface morphology have never been quantified, nor has there been a systematic analysis of how or when these differences arise. This study compares the distal femoral metaphyseal surfaces in an ontogenetic series of chimpanzees (n=58) and humans (n=68) from the fetal period to skeletal maturity. We created three-dimensional models of femora using a surface laser scanner and quantified metaphyseal shape using the Global Point Signature method of shape decomposition. We then used a Linear Model to investigate relationships between metaphyseal morphology, taxon, and locomotor behavior.

We find that the femoral metaphysis is relatively flat in fetal members of both taxa, and only later does chimpanzee and human metaphyseal morphology diverge. Changes in metaphyseal morphology track changes in locomotor mode as chimpanzees become more terrestrial throughout ontogeny. This is consistent with the growth plate depositing bone in response to biomechanical loading, and supports the developmental plasticity of this trait. We conclude that the previously understudied metaphyseal surface will aid in the reconstruction of fossil hominin locomotor behavior.

*The Wenner-Gren Foundation, University of California Davis*

## **Comparative analysis of osteoarthritis and implications for division of labor in two prehistoric skeletal populations**

ALYXANDRA L. STANCO

Geography and Anthropology, Louisiana State University

Numerous studies have been conducted on the relationship between activity-related stress and bone pathology. This study considers sexual differences in labor as inferred by vertebral pathology. The vertebral columns of two prehistoric skeletal populations with different economic lifestyles are observed. The Indian Knoll site, located in Ohio County, Kentucky along the Green River, represents a population of hunter-gatherers and is dated between 2558 and 4160 B.C.; 98 skeletons were observed (n=37 F, n=61 M). The Moundville site, which dates between A.D. 1050 and 1520, is located in the Black Warrior River Valley in west-central Alabama and represents a population of agriculturalists; 56 skeletons were studied (n=31 F, n=25 M). Data were collected on the prevalence of degenerative disease and categorized based on sex and severity of pathology. Vertebrae were given a score of 0-3 based on severity of pathology. Only individuals 18-40 of age were chosen for study. Results show that in both populations males had a higher frequency of osteoarthritis than females. Additionally, females

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in Moundville had a higher incidence of osteoarthritis (45%) than those in Indian Knoll (14%). Males in both populations had identical frequencies of osteoarthritis (58%). Results suggest that 1) males were exposed to a higher level of mechanical stress than females in both populations, and 2) females in Moundville were exposed to a higher level of stress than those in Indian Knoll, but there was no such difference in males.

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### The Influence of EGCG on Cranial Vault Morphology

JOHN STARBUCK<sup>1</sup>, EMILY HARRINGTON<sup>2</sup>, AHMED GHONEMIA<sup>3</sup>, KATHERINE KULA<sup>4</sup> and RANDALL ROPER<sup>5</sup>

<sup>1</sup>Anthropology, University of Central Florida, <sup>2</sup>Biology, Indiana University-Purdue University Indianapolis, <sup>3</sup>Orthodontics and Facial Genetics, Indiana University School of Dentistry, <sup>4</sup>Orthodontics and Facial Genetics, Indiana University School of Dentistry, <sup>5</sup>Biology, Indiana University-Purdue University Indianapolis

Down syndrome (DS) is caused by trisomy 21 (Ts21), which produces a unique constellation of craniofacial phenotypes potentially including brachycephaly, microcephaly, and abnormal facial morphology. The *Dyrk1a* gene is triplicated in most individuals with DS and the Ts65Dn mouse model for Ts21. *Dyrk1a* is a pleiotropic gene involved in multiple developmental pathways including neurogenesis, osteoblast formation and homeostasis, and is expressed in mouse craniofacial primordia. *Dyrk1a* overexpression in Ts65Dn mice likely influences Ts21-induced anatomical dysmorphology. Epigallocatechin-3-gallate (EGCG) is a major polyphenolic compound derived from green tea and an inhibitor of DYRK1A expression. We hypothesized that DS-related craniofacial abnormalities can be improved by treating pregnant Ts65Dn dams with EGCG in vitro to reduce *Dyrk1a* overexpression. To test this hypothesis four samples were analyzed: Ts65Dn (n = 6), Ts65Dn + EGCG (n = 7), euploid (n = 5), and euploid + EGCG (n = 7). Pregnant mice were treated with 200 mg/kg of EGCG twice daily by gavage on E7 and E8. Offspring skulls were imaged using high-resolution  $\mu$ CT (35  $\mu$ m resolution) at 6 weeks after birth. Coordinates of forty-four anatomical landmarks were acquired from images. Craniofacial form differences were statistically assessed using Euclidean Distance Matrix Analysis. Results indicate that EGCG treatment improved Ts65Dn cranial vault morphology but treatment was associated with cranial vault dysmorphology in euploid mice. These results underscore the complexity of the genotype-phenotype map and suggest that changes in *Dyrk1a* expression via EGCG treatment play an important role in morphogenesis and growth of the cranial vault.

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### Isotopic perspectives on human mobility at the Imperial Roman Rue Jacques Brel necropolis (ca. 1<sup>st</sup> to 3<sup>rd</sup> c. CE) in Saintes, France

ROBERT J. STARK and TRACY L. PROWSE  
Anthropology, McMaster University

Isotopes have become an increasingly utilized method for gauging human migration and inter-action in the Roman period. While human mobility is well attested in the Roman era, insights in to individual instances of mobility remain comparatively limited in the textual evidence available.

This study contributes to discussions of Roman mobility in provincial contexts through an isotopic investigation of individuals buried at Rue Jacques Brel (JBR) necropolis, a regional glass and pottery production site located in Saintes, France ~120 km north of Bordeaux. A sample of 39 second molars (M2) were selected for oxygen isotope ( $\delta^{18}\text{O}$ ) analysis, while a sub-sample of 20 M2s were also analyzed for strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ), providing insight to mobility after age ~7–8 years.

Based on the  $\delta^{18}\text{O}$  results, 15/39 (38%) of individuals sampled appear non-local. The  $^{87}\text{Sr}/^{86}\text{Sr}$  results also indicate that a comparable number of individuals appear non-local (6/20, 30%). Combined  $\delta^{18}\text{O}$  and  $^{87}\text{Sr}/^{86}\text{Sr}$  analysis decreases the non-local proportion of the sample to 4/20 (20%) providing a more conservative estimation of local vs. non-local individuals at this site.

The results of this isotopic analysis indicate that even at smaller provincial sites mobility was a common component of Roman society. Though a number of the non-local individuals identified from this sample appear to have been born in regions within France, there is also a significant component of the sample that appears to have arrived at JBR from significantly distant locales, potentially including North Africa and the Near East.

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### Small but healthy? The Shape of Childhood

SARAH Y. STARK<sup>1</sup>, SIMON MAYS<sup>2</sup>, JOANNA R. SOFAER<sup>1</sup> and SONIA R. ZAKRZEWSKI<sup>1</sup>

<sup>1</sup>Archaeology, University of Southampton, <sup>2</sup>Archaeological Science, Historic England

Juvenile growth studies are limited by our current methods of analyzing ontogenetic trajectories. This study evaluates growth (age-and-size) and development (age-and-shape) in the long bones through geometric morphometrics (GM). The application of GM allows for a more thorough analysis of growth and development as whole

bone morphology is analyzed and visualized in a three-dimensional space.

This paper tests if growth and development varies between two English rural settlements of European origins from Anglo-Saxon Great Chesterford versus Medieval Wharram Percy. A dataset of femora (n=36), tibiae (n=26), and humeri (n=35) from 64 juveniles and adolescents ranging from infancy to twelve years old, was collected from Great Chesterford (n=27) and Wharram Percy (n=37). Each element was digitized through structured-light-scanning and a Procrustes (GPA) was used to analyze 10 type I and II landmarks and 100 semi-landmarks.

GM analysis revealed significant differences between age group (p=0.003) and site (p=0.001). The proximal and distal metaphyses (PC1: 46%) and the curvature in the midshaft (PC2: 15%) for all elements are more developed in the Wharram Percy juveniles from two years old onward and potentially reflects different loading patterns among the two populations. The varying rhythms of growth and development are a possible result of different environmental and biomechanical variations from Great Chesterford versus Wharram Percy.

The application of GM is a more sensitive methodology that captures differences in morphological shape that are often overlooked, in this case the metaphyses, and provides a more comprehensive understanding of social and environmental variations of bone growth and form.

### Raccoons, humans and Allen's rule in eastern North America

TED STEEGMANN<sup>1</sup> and RUTH STEEGMANN<sup>2</sup>

<sup>1</sup>Anthropology, University at Buffalo, <sup>2</sup>Graduate School of Education, University at Buffalo

Species conformity to biogeographic rules raises two questions; how strongly do different species fit the rules? And, when a species matches the rule's prediction, what are the causes? We outline a new research project comparing raccoons (*Procyon lotor*) and humans for their conformity to Bergmann's size rule, Allen's extremity length rule, and Thomson's nose shape rule. Populations of each species share distributions in eastern North America from sub-arctic Canada to sub-tropical Florida. If climatic factors induce biogeographic patterns, variation of North American environments are a sufficient test. Other factors including foraging and defensive behaviors, disease, and famine resistance will be presented in a general causal model that considers natural selection as well as plasticity responses. Morphological fit to the rules is determined by standard osteological analysis of museum specimens and published data. Currently, raccoon data collection is complete and some human material is recorded. As an example of forthcoming results we offer a preliminary analysis of male raccoon conformity

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to Allen's rule. Measures are confined here to rear leg length and relative tibia length as expressed by the crural index. Sample sizes are 25 (north) and 16 (south). The northern sample has significantly shorter legs using femur length plus tibia length (north = 242.3mm, SD = 15.27); (south = 258.7mm, SD = 11.99). Likewise, the northern sample shows a relatively shorter tibia as estimated by tibia lt./femur lt. x 100 (north = 103.1, SD 2.17); (south = 105.4, SD = 2.39). This first test shows raccoon conformity to Allen's rule.

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### Evidence for elevated diversity in genes linked to facial diversity in apes supports the hypothesis that individual facial recognition is important across hominoids

MICHAEL E. STEIPER<sup>1,2,3,4</sup>, NATALIA T. GRUBE<sup>1</sup> and CHRISTIAN M. GAGNON<sup>1</sup>

<sup>1</sup>Anthropology, Hunter College CUNY, <sup>2</sup>Human Biology Program, Hunter College CUNY,

<sup>3</sup>Anthropology Program, The Graduate Center CUNY,

<sup>4</sup>New York Consortium in Evolutionary Primatology (NYCEP)

The ability to use visual cues to identify individuals is an important feature of primate social groups, including humans. In 2014, Sheehan and Nachman showed that genes linked to facial morphology had elevated levels of diversity when compared to both neutral loci and loci linked to height in humans, suggesting that the human face is under frequency-dependent selection to enhance individual recognition (Nature Communications 5). In our study, we tested whether this pattern is found in other great ape species by examining levels of genetic diversity in publicly-available population genomic datasets of hominoid species. We found significantly elevated diversity in genes linked to facial morphology in chimpanzees, gorillas, and Sumatran and Bornean orangutans. Our findings closely parallel Sheehan and Nachman's and suggest that selection for facial diversity and individual recognition has not only shaped the evolution of the human face, but it has similarly shaped the evolution of most of our closest primate relatives.

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### Exploring an Undersampled Interval in Primate Evolutionary History: Insights from the Late Oligocene Nsungwe Formation of Tanzania

NANCY J. STEVENS<sup>1</sup>, ERIC M. ROBERTS<sup>2</sup> and PATRICK M. OCONNOR<sup>1</sup>

<sup>1</sup>Heritage College and Center for Ecology and Evolutionary Studies, Ohio University, <sup>2</sup>College of Science and Engineering, James Cook University

Much of what we know about Oligocene continental African faunas derives from the northern portion of the continent, largely due to decades of research by teams in the Jebel Qatrani Formation of Egypt. Subsequently, only a handful of sites are known until the early Miocene localities in

eastern and southern Africa, making the Late Oligocene one of the least-sampled intervals in primate evolutionary history. Research in the Nsungwe Formation (Rukwa Rift Basin, southwestern Tanzania) helps address this gap, providing key data from the 26-24 Ma interval on Africa south of the equator. Nsungwe sites transition from proximal alluvial fan systems into a complex, volcanically-influenced landscape of fluvial, alluvial and lacustrine depositional environments. Individual localities are dated via high-precision U-Pb and Ar/Ar geochronology of intercalated volcanic tuffs, and sedimentological results suggest seasonal aridity with perennial availability of water. Faunal results indicate a distinctive Paleogene vertebrate assemblage, with mammals spanning a diversity of body sizes and ecological specializations. Other vertebrates include fish, anurans, turtles, crocodylians, snakes, lizards and birds. Interestingly, evidence reveals that parapithecoid and propliopithecoid primates persisted until at least 25 Ma. Other primate discoveries include the first loriform from Africa south of the equator and the earliest evidence of the split between cercopithecoids and hominoids. This rare glimpse into African Late Oligocene terrestrial and freshwater habitats provides opportunities for recognizing trends in faunal patterns across habitat types and through time, set within the context of a complex tectono-sedimentary history throughout the African Paleogene.

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### Estimation of Sex in Fragmentary Archaeological Populations: A Test of Post-Cranial Estimation Methods

MARISSA C. STEWART and GIUSEPPE VERCELLOTTI

Anthropology, The Ohio State University

The assessment of sex is a crucial aspect of bioarchaeological research. However, limitations associated with bioarchaeological samples (e.g., skeletal completeness, taphonomic changes) can often preclude the use of proven and well-accepted sex estimation methods based on sexually dimorphic features of the pelvis. When traditional methods cannot be used, bioarchaeologists have limited options to incorporate an individual's sex into their analyses, thus limiting the inferential power of their analyses. Methods developed from the relationship between bone sizes and sex may be used; however, their accuracy and applicability to archaeological samples has not been proven. In this study, we tested the accuracy of sex-estimation methods using standard

osteometric measurements in a well-preserved medieval Italian skeletal collection. Ideally, methods based on similar geographic, temporal, and biological samples would be used; however, those methods are often not available for bioarchaeologists. Three separate methods (and sixteen separate measurements) were tested to determine the successful classification rates of each as compared with pelvic sex estimations. After calculating the success with which these methods could estimate sex, it was determined that six of the sixteen measurements examined had a success rate over 80% (and as high as 92%) and an incorrect classification rate of 10% or less. In situations where previously developed methods and formulae are not available in bioarchaeological research, this project serves as a model for a way to determine the most appropriate methods to use, even if developed from other contexts, prior to applying them to new bioarchaeological samples to increase sex-specific sample sizes.

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### Horticultural activity predicts later localized limb status in a contemporary pre-industrial population

JONATHAN STIEGLITZ<sup>1</sup>, BENJAMIN TRUMBLE<sup>2</sup>, HILLARD KAPLAN<sup>3</sup> and MICHAEL GURVEN<sup>4</sup>

<sup>1</sup>Anthropology, Institute for Advanced Study in Toulouse, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Anthropology, University of New Mexico, <sup>4</sup>Anthropology, University of California-Santa Barbara

It is hypothesized that modern humans have more gracile skeletons than other hominoids and extinct hominins due to lower physical activity levels and mechanical loading. Empirical tests using prehistoric skeletal remains are limited by the inability to assess behaviour directly, while modern industrialized societies possess few socio-ecological features typical of human evolutionary history. Here we use in vivo quantitative ultrasonography at multiple skeletal sites varying in loading in a contemporary pre-industrial population, Tsimane forager-horticulturalists of lowland Bolivia, to test whether greater activity levels and loading earlier in life are associated with greater later-life bone status, and diminished age-related bone loss. We find that structural decline is lower for the tibia (female: -0.25 SDs/decade; male: 0.05 SDs/decade) versus radius (female: -0.56 SDs/decade; male: -0.20 SDs/decade), as expected if loading influences rate of bone loss. Horticultural, but not hunting activity, positively predicts radial status ( $\beta_{\text{horticulture}}=0.483$ ,  $p=0.01$ ), whereas tibial status is not significantly predicted by subsistence or sedentary leisure participation. These results suggest that gradual transition from a hunting and gathering subsistence regime to domesticated plant production was not uniformly linked to skeletal gracility.

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## Early and Middle Epipalaeolithic human remains from Jordan: implications for understanding late Pleistocene population and foraging complexity in the Levant

JAY T. STOCK<sup>1</sup>, EMMA POMEROY<sup>1,2</sup>, THOMAS DAVIES<sup>3</sup>, TOBIAS RICHTER<sup>4</sup> and LISA MAHER<sup>5</sup>

<sup>1</sup>Department of Archaeology and Anthropology, University of Cambridge, <sup>2</sup>School of Natural Sciences and Psychology, Liverpool John Moores University, <sup>3</sup>School of Earth Sciences, University of Bristol, <sup>4</sup>Department of Cross-Cultural and Regional Studies, University of Copenhagen, <sup>5</sup>Department of Anthropology, University of California, Berkeley

Our understanding of the Epipalaeolithic of the Levant has been dominated by research on late Epipalaeolithic (Natufian) foragers and their relatively sedentary lifestyles and socially complex culture. The early and middle Epipalaeolithic periods, however, show many signs of this complexity shortly after the last glacial maximum (20-19kya). Sites such as Ohalo II, Kharaneh IV and Jilat 6 provide evidence of aggregation of larger populations over long periods of time, and demonstrate a rich material culture and social complexity including multiple architectural features. Our understanding of biological diversity among Early and Middle Epipalaeolithic foragers, however, is poorly resolved. Here we provide morphometric analyses of new skeletal remains from the sites of Ayn Qasiyya, Kharaneh IV and 'Uyun al-Hammam, Jordan which, dating variously to between 24-16,000 cal BP, provide new insights into Early and Middle Epipalaeolithic diversity.

Phenotypic diversity, as reflected by body size, robusticity and craniofacial features, is high among the Early and Middle Epipalaeolithic skeletons relative to the Natufian. While Natufian foragers are relatively homogenous with small body size and gracile skeletons suggestive of a trend towards sedentism, the Early and Middle Epipalaeolithic remains show variable patterns of diversity with some individuals featuring highly robust postcrania and others gracile phenotypes. While there is cultural evidence for population continuity in the Levant throughout the Epipalaeolithic, the results presented here demonstrate a considerable diversity in population structure and habitual activity in the pre-Natufian Epipalaeolithic.

This work was supported by the Arts and Humanities Research Council, UK (AHRC), and the European Research Council (AdAPt Project: FP7-IDEAS-ERC 617627).

## Quantitative assessment of age-related topographic changes in the pubic symphysis

MICHALA K. STOCK<sup>1</sup>, PAUL E. MORSE<sup>1,2</sup> and CHIARA VILLA<sup>3</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>Florida Museum of Natural History, University of Florida, <sup>3</sup>Laboratory of Biological Anthropology, Department of Forensic Medicine, University of Copenhagen, Denmark

Estimating age from skeletal remains constitutes a fundamental aspect of constructing the biological profile in bioarchaeology and forensic anthropology. Age estimation in adults is complicated by many methods' reliance on practitioner experience to generate accurate age estimates. Recently developed quantitative methods for characterizing dental topographic surfaces can be applied to the pubic symphysis in order to provide an unbiased metric for use in estimating age-at-death. Symphyseal joint surfaces were isolated from CT scans of the 24 Suchey-Brooks casts and 98 Terry Collection individuals. Prior to analysis, the surfaces were smoothed, simplified to a consistent face count, and uniformly auto-aligned using *auto3dgm*. Surfaces were analyzed for their Dirichlet normal energy (DNE), an integrated value using changes in normal vectors to express total surface curvature, using the R package *molar*.

The relationship of DNE measurements to age in the Suchey-Brooks casts conforms to a second order polynomial model for males ( $S = 37.96$ ) and females ( $S = 30.13$ ), but above age 50 both samples' surfaces exhibit such great variability that DNE is no longer correlated with age. When the samples are restricted to individuals younger than 50 years, a linear regression best describes the fit, with the female sample exhibiting a significant correlation between age-at-death and DNE ( $R^2=0.54$ ,  $p=0.02$ ), and a statistically non-significant trend ( $R^2=0.23$ ,  $p=0.19$ ) in the male sample. These results indicate that DNE identifies surface changes useful for estimating age-at-death in younger individuals, while further investigation is still necessary to objectively discriminate older versus younger individuals using this topographic metric.

## Population movements throughout northern Africa during the Pleistocene-Holocene transition

CHRISTOPHER M. STOJANOWSKI, REBECCA BOOKMAN and CHARISSE L. CARVER  
School of Human Evolution and Social Change, Arizona State University

The improving climate of the Holocene witnessed rapid expansion of human populations into and throughout northern Africa over a relatively short period of time. Scholars have debated the source of these population movements for decades, with

little agreement. Archaeological and linguistic evidence suggests a westward expansion from the Nile Valley. Physical anthropological evidence suggests movement from the Maghreb south into the western and central Sahara. Climate data suggests a south to north movement of peoples as populations were drawn further north with an improving climate. This poster presents new evidence from the Holocene assemblage of Gobero combined with comparative data from Late Pleistocene and Early Holocene sites from west and east Africa in addition to the Nile Valley and Maghreb. Data are presented on craniometrics, dental morphology, limb bone proportions, and dental ablation patterns. Craniometric data suggest Early Holocene connections to the Maghreb, an inference supported by dental ablation patterns, with no similarity to the Iwo Eleru skull. Dental morphological data, however, suggest a mosaic of north and sub-Saharan African morphology. Consideration of limb bone proportions presents a tropically adapted body morphology consistent with sub-Saharan African affinities for all burials from Gobero. Both dental morphological and long bone data sets indicate population continuity throughout the Holocene sequences at Gobero, which contradicts the craniometric data. These different signals must be interpreted cautiously given the challenges with spatio-temporal variation and access to archaeological samples of the appropriate age for evolutionary comparisons.

## Ancient TB in the Americas: the partnership between bioarchaeology and genetics to identify a killer

ANNE C. STONE<sup>1</sup>, TANVI HONAP<sup>2</sup>, ÅSHILD J. VÅGENE<sup>3</sup>, JANE E. BUIKSTRA<sup>1</sup>, ALEXANDER HERBIG<sup>3</sup>, KIRSTEN I. BOS<sup>3</sup> and JOHANNES KRAUSE<sup>3</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>School of Life Sciences, Arizona State University, <sup>3</sup>Archaeogenetics, Max Planck Institute for the Science of Human History

Ancient DNA research about the cause(s) of tuberculosis (TB) in the Americas stands on the shoulders of decades of paleopathological and bioarchaeological research that has identified diagnostic lesions of TB in skeletal samples, examined the patterning of disease within sites and diachronically across regions, and hypothesized about origins of TB in the Americas. Complementary to bioarchaeological data are genetic data which provide insight into phylogenetic relationships and divergence times among TB strains and adaptation during the evolutionary history of the pathogen. Previously, we sequenced the complete *Mycobacterium tuberculosis* genome from three Peruvians dating to ~1000 years ago. Our analyses indicated that in the Americas, *M. tuberculosis* likely "jumped" into humans from pinnipeds (seals and sea lions) that

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brought it from Africa within the last 2000 years. These results lead to questions about whether the Peruvian cases were zoonotic given the archaeological evidence for fishing (or regular trade/contact with the coast) at these sites or whether the pinniped strain had transitioned to human-to-human transmission. In addition, despite archaeological evidence for the earliest cases of TB in South America, the possibility of other introductions pre-contact via the Bering Strait remain. We screened ~80 pre- and post-contact samples from North and South America using qPCR assays and shotgun sequencing. Ten samples were positive for the IS6110 and IS1081 *M. tuberculosis*-specific elements, and eight were positive for the *rpoB* gene. The endogenous DNA content of these samples ranged from 0.01 to 0.1% necessitating TB-genome enrichment prior to sequencing, which is currently in progress.

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### Face in the Sand: Island Rules, Biogeography, and the Fallacy of Palauan Hobbits

JESSICA H. STONE and SCOTT M. FITZPATRICK  
Department of Anthropology, University of Oregon

The "Island Rule" is an ecogeographical principle which states that members of a given species will change body size based on either the (un)availability (dwarfism) or abundance (gigantism) of resources in the surrounding environment. While there are many examples of insular dwarfing and gigantism among various reptile, bird, and mammal species across different island regions, some controversy remains regarding the applicability of this phenomenon globally. One of the more recent and contentious cases regarding insular dwarfism in anthropology involves purported small-bodied humans from the Ucheliungs Cave in Palau, Micronesia that called into question the validity of *Homo floresiensis* as a separate species. While these results have previously been disputed based on a host of archaeological, biological, and linguistic data, we now present results from further test excavations conducted at Ucheliungs in 2015. In contrast to previously reported findings, our results indicate an abundance of faunal material, human remains, and artifacts at the site that call into question the methods and analyses used to document the presence of smaller individuals here. Along with new radiocarbon dates from the site, results instead support long-term use of the cave for both mortuary activity and possibly small scale marine foraging that is contemporary with the earliest known human activity in Palau. Results also support the need to carefully examine all aspects of archaeological and other lines of evidence to satisfactorily support a hypothesis

suggesting the presence of insular dwarfing and challenge the assumption that small islands are marginal environments for prehistoric human populations.

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### The Earliest Urban Environment in Precolumbian Mesoamerica: Transitions through Time in Health and Morbidity in the Residents of Teotihuacan, Mexico

REBECCA STOREY

Anthropology Program, University of Houston

The preindustrial city (circa BCE 100 to 600 CE) of Teotihuacan, Mexico, had a dense population of perhaps 80,000 - 100,000 residents in the arid, highland Valley of Mexico. This was the earliest settlement to reach this size in North America and thus presented a novel environment for residents, urbanism. Early residences are poorly known and of perishable materials. By circa 250 CE, when the city reached its largest size through migration, most of the population was soon living in masonry, multi-apartment compounds, the distinctive residential architecture of the city. Thus, many individuals and families, who had recently been living in smaller communities in probable single households, had to transition to living and working intimately within larger social, economic, and political structures. Isotope analysis reveals that recent migrants to Teotihuacan comprise at least 30% of the skeletons. Preindustrial cities usually afforded more economic opportunities than smaller, rural communities but also presented a more challenging health environment for both residents and migrants. Failures of sanitation and the easier circulation of communicable diseases were common with larger populations. Thus, cross-culturally, individuals were prone to more morbidity and earlier mortality, especially of children and newcomers. Skeletons of low-status residents on the south periphery of Teotihuacan had 80-100% prevalence of the markers of morbidity, especially on infants and children. Through time, subadults and young adults became the majority of deaths, indicating a deteriorating urban environment too challenging for these residents. This urban environment required constant adaptive transitions, and it ultimately failed after 300-400 years.

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### Left or Right Pubic Symphysis: Asymmetry Analysis of Age-at-Death Estimation Using 3D Laser Scans and Computational Algorithms

DETELINA K. STOYANOVA<sup>1</sup>, BRIDGET F.B. ALGEE-HEWITT<sup>1,2,3</sup>, JIEUN KIM<sup>1,3</sup> and DENNIS E. SLICE<sup>1,4</sup>

<sup>1</sup>Scientific Computing, Florida State University,

<sup>2</sup>Department of Biology, Stanford University,

<sup>3</sup>Department of Anthropology, Florida State University, <sup>4</sup>Department of Anthropology, University of Vienna

Age-at-death estimation is crucial for building individual forensic profiles and studying mortality in past populations. For decades, anthropologists have relied on imprecise age estimation techniques based on the visual inspection of the pubic symphysis. Recently several computational methods using 3D laser symphyseal scans have been proposed as accurate, reliable and objective alternatives to current practices. The methods include two surface analysis algorithms, one ventral outline measure, and two multivariate-regression models combining each surface measure with the outline score. The five proposed models are calibrated on 3D scans from white males where the left or right pubic symphysis was randomly selected. A question remains whether the asymmetry of the two surfaces affects the age estimates. For this study both the left and right pubic symphyses from 25 white males are scanned. Both sides are used to estimate the age-at-death for each individual using the five computational models. Additional tests are performed by selecting 25 individuals for whom the left or right symphyseal scan is included in the data for the models. For those males the age-at-death is estimated using the opposite side. The results of paired t-tests for mean differences, Wilcoxon rank sum tests for median differences and Kolmogorov-Smirnov tests for distributional differences show that there is no significant difference (p-values > 0.26) between the age estimates of the two sides for the 50 males. The Spearman and Pearson correlations are robustly positive, between 0.47 and 0.72 (p-value < 0.05), suggesting a monotonic relationship with high degree of linear dependence.

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### Testing hypotheses about early hominin feeding adaptations

DAVID S. STRAIT

Anthropology, Washington University in St. Louis

The identification of adaptations in extinct species is one of the major objectives of paleobiology, and there is a long and distinguished history in Anthropology of attempting to define the criteria by which the presence of adaptation can be inferred. This approach has salience but an alternative framework exists. In short, a putative

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adaptation in a fossil species is a hypothesis to be tested. Testable predictions of the hypothesis must be identified, and attempts made to falsify them. This process does not identify adaptation per se, but the number of viable adaptive explanations for the evolution of a given trait is narrowed through a process of elimination. Predictions of adaptive hypotheses can be gleaned from a consideration of first principles of evolutionary biology. Adaptation is the end product of natural selection, so an adaptive hypothesis carries with it the implication that heritable variation once existed in which a given variant conferred a competitive advantage under certain ecological conditions, leading to increased fitness in the possessors of the variant and the eventual fixation of the variant as a novel trait in the population. Testable predictions inherent in such a hypothesis concern heritability, biomechanical/functional/behavioral performance, paleoecology, and character evolution as inferred from phylogeny. Falsification of any one such prediction should result in rejection of the hypothesis as a whole. This approach is applied to the recent debate regarding dietary adaptations in australopithecids. Finite element analysis shows that some facial buttressing traits are not adaptations that biomechanically strengthen the face.

*This research was supported by a National Science Foundation HOMINID grant (NSF BCS 0725126).*

### Intraspecific Variation Among Plio-Pleistocene Primates of South Africa

RENE STUDER-HALBACH

Anthropology, Rutgers University

The fossil cave sites of South Africa contain many species of primates living sympatrically. Given the taxonomic relatedness of those species, it is likely that they interacted and affected each other ecologically. My hypothesis is that species present at more than one site will display variation in accordance with the primate community composition of those sites.

In this project, I have recorded a series of 20 craniodental measurements (lengths and widths of dentition, post-canine tooth row length, palate breadth, orbital height, orbital breadth, maxilla-alveolar breadth, maxilla-alveolar length, nasal height, nasal breadth, inter-orbital breadth, foramen magnum length, foramen magnum width, and mandibular corpus depth) on the fossil primate collections housed at the Witwatersrand University, Johannesburg, and the Ditsong National Museum of Natural History, Pretoria, South Africa. The species sampled are *Australopithecus africanus*, *Paranthropus robustus*, *Cercopithecoides williamsi*, *Papio izodi*, *Papio augusticeps*, *Papio robinsoni*, *Parapapio broomi*, *Parapapio whitei*, *Parapapio jonesi*, *Theropithecus oswaldi*, *Theropithecus darti*, and *Dinopithecus ingens*. The sites from which

these species were collected are Makapansgat, Swartkrans, Sterkfontein, Kromdraai, Cooper's Cave, Taung, and Bolt's Farm.

Such a large data set has many opportunities for analysis, but some results are of particular interest. *Cercopithecoides williamsi*, which is found at many sites, has larger dental dimensions at Kromdraai than at any other site. The mean M2 mesio-distal length is 10.6 mm at Kromdraai, and 9.37 mm at Bolt's Farm, Makapansgat, Sterkfontein, and Swartkrans. The bucco-lingual dimension is 10.3 at Kromdraai, and 8.22 at the other sites. More such comparisons are found in these data.

*Thanks to the Center for Human Evolutionary Studies at Rutgers University for the funding to carry out this research.*

### The effects of epiphyseal fusion asymmetry on juvenile age estimation

KYRA E. STULL<sup>1</sup> and LOUISE CORRON<sup>2</sup>

<sup>1</sup>Anthropology, University of Nevada, Reno,

<sup>2</sup>Anthropologie bioculturelle Droit Ethique et Santé, Aix-Marseille University

While the general consensus is that developmental asymmetry is not statistically significant, authors often specify the laterality or whether the highest/lowest stage should be used in anthropological methods. Few authors have explored the implications of developmental asymmetry on age estimation, or their practical significance. The current study explores developmental asymmetry and the effects on the final age estimation.

Epiphyseal fusion of three acetabular epiphyses and the ischiopubic branch epiphysis on both left and right sides of the subadult pelvis was scored using a three-stage system. The data was collected from computed tomography images of 417 individuals ranging from 0 to 19.95 years from Marseilles, France. Single variable transition analysis models with a Bayesian age estimation were developed for left- and right-sided elements and the most advanced and delayed elements in order to compare the effects on the final age estimates.

Developmental asymmetry occurred in 6.4% of the entire sample. The site with the most asymmetry was the ischiopubic branch (3%) and the least was at the pubo-ischiatic acetabular epiphysis (1%). Differences in mean age of transition were as large as one year and there is greater discrepancy in the mean ages of transition among left and right-sided elements. Model accuracy fluctuated with the differing levels of asymmetry.

While the percentages are low, the current study only investigated one anatomical region and has decreased precision due to utilization of a three-stage system. Recommendations based on the findings include incorporating a multiple variable model, as this would decrease the effects of asymmetry.

### Biosocial Changes in Health before Agriculture: The Case of the Natufian Hunter-Gatherers

AARON J. STUTZ<sup>1</sup> and FANNY BOCQUENTIN<sup>2</sup>

<sup>1</sup>Division of History & Social Sciences, Oxford College of Emory University, <sup>2</sup>Equipe Ethnologie Préhistorique, CNRS

The Natufian archaeological culture (ca. 15,000-12,000 BP) traces those last hunter-gatherer populations in the region who lacked any farming neighbors. The Natufian geographic sphere encompasses remarkable social, technological, and ecological change and diversity. Some Natufian groups established and occupied sedentary hamlets over multiple generations. Others remained highly mobile. In the southern Levant, in particular, archaeological evidence indicates a likely increase in plant food processing in the Late/Final Natufian period (ca. 13,000-12,000 BP). It remains incompletely understood how variations in demography and health were involved in increasing sedentism and economic intensification prior to agriculture. Natufian mobile camp sites and sedentary hamlets alike often incorporate inhumations, providing the largest Pleistocene-age mortuary sample of a regional population. In an earlier analysis of linear enamel hypoplasias (LEH) in 138 southern Levantine Natufian individuals, we found evidence for substantial heterogeneity in adult mortality risk. This strong signal of adult mortality selection was restricted to the Early Natufian period, with the Late/Final Natufian sample showing improvements in health in all life history stages. This study examines how non-metric craniodental traits associate with LEH in the Natufian sample—across juvenile, younger adult, and older adult life history stages. Preliminary results on non-metric trait variation indicate that Late/Final Natufian populations in the southern Levant exhibited reduced geographic structure among sites. This analysis aims to clarify the biological and social factors influencing variation in health and mortality as overall Late/Final Natufian well-being improved. The systemic connections between variation in well-being and socio-technological change leading to agriculture are discussed.

### *Australopithecus afarensis* habitat diversity: a unique perspective from Laetoli, Tanzania

DENISE F. SU<sup>1</sup> and TERRY HARRISON<sup>2</sup>

<sup>1</sup>Department of Paleobotany and Paleoecology, Cleveland Museum of Natural History, <sup>2</sup>Center for the Study of Human Origins, Department of Anthropology, New York University

*Australopithecus afarensis* is one of the best-sampled and well known early hominin species, found from numerous Pliocene sites in Ethiopia, Tanzania, and Kenya. The environments at these sites are reconstructed as mosaic with varying proportions of grassland, bushland,

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shrubland, and woodland. However, the overall vegetation structure of each site was likely quite different, which would have had important ecological implications for local populations of *A. afarensis*. Laetoli, an *A. afarensis*-bearing site located in northeastern Tanzania, samples sediments dated to 3.6-3.85 Ma. It is unique among *A. afarensis* sites in the lack of a permanent, large body of water, which likely resulted in a vegetation structure considerably different from the other sites. We compared the paleoenvironment of Laetoli with two *A. afarensis*-bearing sites (Hadar and Woranso-Mille) using a variety of ecological proxies. The results indicate that although all three sites may have experienced significant seasonality, Laetoli samples a more open and arid habitat likely due to the lack of the mediating effects of a permanent source of water. This would have had important implications for *A. afarensis* habitats at Laetoli. Compared to Hadar and Woranso-Mille, *A. afarensis* was apparently a much rarer component of the Laetoli fauna. This implies that Laetoli may represent a sub-optimal environment for *A. afarensis* that could only support a relatively low population density. This may suggest that water-margin habitats may have provided key resources that had a direct impact on the population density of *A. afarensis*.

Fieldwork at Laetoli was supported by Grants from National Geographic Society, the Leakey Foundation, and the National Science Foundation (Grants BCS-0216683, BCS-9903434, BCS-0309513, BCS-1350023).

### Incorporating Spatial Analysis into a Whole-epiphysis Approach to Studying Trabecular Bone Structure in the Distal Femur of *Homo*, *Pan*, *Pongo*, and *Papio*

SIMONE M. SUKHDEO<sup>1</sup> and TIMOTHY M. RYAN<sup>1,2</sup>

<sup>1</sup>Anthropology, Pennsylvania State University, <sup>2</sup>Center for Quantitative Imaging, EMS Energy Institute, Pennsylvania State University

The complex morphology of the knee joint poses a challenge to the analysis of trabecular bone structure in studies of locomotor adaptation. Traditional methods are restricted in their ability to fully characterize this complex joint. Recently, a whole-epiphysis approach was developed to quantify trabecular bone structure throughout an entire epiphysis. This study aims to investigate patterns of trabecular bone structure in the distal femur using the whole-epiphysis approach and characterize the distribution of high bone volume fraction (BV/TV) using spatial analyses. MicroCT scans of the distal femur were obtained for *Homo*, *Pan*, *Pongo*, and *Papio* (n=24). Trabecular bone was analyzed in medtool. Results show *Papio* exhibits significantly higher mean BV/TV than the other taxa, but with a significantly smaller coefficient of variation (CV). *Homo* exhibits similar mean BV/TV values as *Pan* and *Pongo*, but with significantly higher variability (high CV) than the other taxa.

The locations of high BV/TV were extracted from each condyle. Ripley's *K*-function revealed that all condyles of all taxa exhibited non-random spatial clustering. The nature of the clustering was explored using two dispersion indices. The results showed statistically significant differences among the four taxa. *Homo* showed the highest index values, indicating a more clumped distribution of high BV/TV. *Papio* demonstrated the lowest values, indicating a less clumped distribution, with *Pongo* and *Pan* falling intermediately. These results suggest that the distribution and nature of clustering of high BV/TV in the femoral condyle could represent a potential signal within trabecular bone structural variation for distinguishing locomotor behavior.

This research was funded by National Science Foundation Grant BCS-0617097 (to TMR) and the Department of Anthropology at Pennsylvania State University.

### Are jumping tree animals getting smaller over time because humans catch and eat the larger ones?

ALEXIS P. SULLIVAN<sup>1</sup>, LAURIE R. GODFREY<sup>3</sup>, RICHARD LAWLER<sup>4</sup>, TIMOTHY RYAN<sup>2</sup> and GEORGE PERRY<sup>1,2</sup>

<sup>1</sup>Biology, The Pennsylvania State University,

<sup>2</sup>Anthropology, The Pennsylvania State University,

<sup>3</sup>Anthropology, University of Massachusetts Amherst,

<sup>4</sup>Anthropology, James Madison University

The arrival of humans on Madagascar >2,900 years ago precipitated major changes to the island's biodiversity. The now-extinct, endemic "subfossil" megafauna of Madagascar were likely hunted by the island's early human inhabitants. Perhaps in part due to preferential hunting of larger animals, no surviving species on Madagascar is larger than 10 kg. Outside Madagascar, size-selective hunting pressure has resulted in the phyletic dwarfism of multiple species across many phyla. On Madagascar, some subfossil bones of still-living lemur species are considerably larger than those of the modern members of their species, but the different locations of the subfossil and modern samples analyzed to date makes it impossible to reject the possibility that these size differences reflect pre-existing ecogeographic variation. However, for this study we conducted a comparative morphological analysis of subfossil Verreaux's sifaka (*Propithecus verreauxi*, one of the larger extant lemurs) bones from Taolambiby to the skeletal remains of their modern counterparts (n=34 individuals) at the adjacent Beza Mahafaly Special Reserve (<10km from Taolambiby). The Taolambiby sifaka material, dating from ~1,185-0 BP, has many verified processing marks from human activity. Our initial analysis with caliper measurements suggested that the subfossil sifaka bones are not significantly larger than those of the modern sifakas (femoral intercondylar gap width, n=4, t-test;

$P=0.375$ ), consistent with the null hypothesis of no body size evolution in response to human hunting pressure. We are currently using high-resolution 3D scanning technology to expand the subfossil sample size (facilitating the inclusion of more fragmentary specimens) and then repeat the analysis.

This material is based on work supported by the National Science Foundation Graduate Research Fellowship Program (DGE1255832, to A.P.S.).

### Toxin Evolution for Organismal Defense: Is Ethanol a Special Case?

ROGER SULLIVAN

Anthropology, CSU Sacramento

Most of the drugs commonly used by people are plant toxins (e.g. coffee, tobacco, cannabis) or their commercial derivatives (e.g. opiate analgesics). These toxins appear to be plant defenses that are the product of a co-evolutionary dynamic of plant-predator antagonism. This dynamic has produced a range of neurotoxins selected to interfere with the function of animal and human nervous systems (NS) by binding to specific NS sites, or by mimicking and substituting NS neurotransmitters (e.g. nicotine and nicotinic acetylcholine receptors).

On the other hand, the evolution of ethanol has followed a markedly different path. Unlike the commonly-used plant substances, ethanol appears to have evolved from competition between yeasts and bacteria for access to plant sugars, and is not a defensive molecule that has evolved with a specific binding target in animal (and human) nervous systems. Further, whereas plant toxin evolution is the product of plant-predator antagonism, ethanol evolution also incorporates plant-animal mutualism in aid of seed dispersal.

This study analyses the similarities and differences between plant toxin and ethanol evolution. It finds that the distinct co-evolutionary dynamics leading to ethanol evolution have implications for understanding animal and human consumption behaviors and therapeutics.

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### Finite Element Modeling of Talar Loading in Modern Humans with Application to the Hominin Fossil Record

ZANE S. SWANSON<sup>1,2</sup>, NICOLE M. WEBB<sup>1,2</sup>, HERMAN PONTZER<sup>1,2,3</sup>, JEREMY M. DESILVA<sup>4</sup> and WILLIAM E.H. HARCOURT-SMITH<sup>1,2,5,6</sup>

<sup>1</sup>New York Consortium in Evolutionary Primatology,

<sup>2</sup>Department of Anthropology, The Graduate Center (CUNY),

<sup>3</sup>Department of Anthropology, Hunter College,

<sup>4</sup>Department of Anthropology, Dartmouth College,

<sup>5</sup>Department of Anthropology, Lehman College,

<sup>6</sup>Division of Paleontology, American Museum of Natural History

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With fossil taxa it is often difficult to rigorously test inferences pertaining to locomotor behavior due to an imprecise understanding of the biomechanical relationship between skeletal elements and their associated function. One potential solution to this problem is Finite Element Analysis (FEA), a technique that permits the modeling of various loading scenarios. A critical component of robust FEA studies is using experimental biomechanical data to inform modeling of stress distributions. We present FEA data on the talus of adult modern humans and extend their parameters to bipedal fossil hominins.

To accurately estimate the boundary conditions of our human models, kinematic and kinetic data were collected from individuals for whom a model talus was digitally extracted from high-resolution MRIs. Force plate (1000Hz) and high-speed 3D kinematics (200Hz) were collected simultaneously at multiple walking speeds (0.72m/s-1.37m/s) per subject. Force recordings were used to determine the timing of heel strike and toe-off. Finite element models for each point of stance phase were then generated using bone-based shell models subjected to FEA using established parameters from the literature and kinematic/kinetic data obtained from the same subjects.

Integrating MRI and walking data, we present models of stress distributions through the talus in modern humans. Notably, the dorsal talar neck, lateral malleolar facet, and lateral posterior calcaneal facet experience highest stresses at heel-strike. Using these loading patterns and adjusted force to reflect estimated fossil hominin body masses, both OH8 and MH2 models indicate patterns and magnitudes of stress distribution distinct from each other and modern humans.

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### Hamadryas Baboons as Analogs for Social Evolution in Early Homo

LARISSA SWEDELL<sup>1,2,3</sup> and THOMAS PLUMMER<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, Queens College, City University of New York, <sup>2</sup>New York Consortium in Evolutionary Primatology, <sup>3</sup>Department of Archaeology, University of Cape Town

Paleoanthropological reconstructions have long benefited from comparisons with nonhuman primates, especially 'savanna' baboons and chimpanzees. This is especially true for human social evolution, as analogies with evolutionary processes shaping the social behavior of nonhuman primates can inform our understanding of such processes during hominin evolution. Here we link behavioral processes in hamadryas baboons (*Papio hamadryas*) with those in Plio-Pleistocene hominins, particularly *Homo erectus*. *H. erectus* has been argued

to represent a pivotal species in that its larger body and brain size and more extensive ranging patterns increased costs of reproduction for females, potentially selecting for greater levels of sociality than in earlier hominins. These higher costs of reproduction, exacerbated by an increased reliance on difficult to acquire, nutrient-dense foods, are thought to have been alleviated by a strengthening of male-female bonds (via male provisioning and the evolution of monogamy) or the assistance of older, post-reproductive females (via grandmothering). We suggest that both of these social arrangements could have been present in Plio-Pleistocene hominins if they lived in multilevel societies. We expand on our earlier (2009, 2012) scenario by presenting two sets of recent data in support of it, (1) archaeological data from the 2 Ma Oldowan site of Kanjera South, Kenya that is suggestive of tool dependent foraging of nutrient dense resources (animal carcasses and USOs) amenable to food sharing, and (2) a patterning of genetic variation in hamadryas baboons at Filoha, Ethiopia that is suggestive of kin selection among both males and females at multiple levels of social organization.

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### Dental Crown Morphological Variation at the Boothill Burial Ground: Ancestry Estimation Using rASUDAS

JAIME D. SYKES, KIRSTEN A. VEROSTICK, ERIN H. KIMMERLE and JONATHAN BETHARD  
Anthropology, University of South Florida

Morphological dental variation is tightly genetic, allowing biological anthropologists to utilize these traits as proxies for genetic data when reconstructing population histories. Forensic anthropologists may similarly consider these traits when estimating ancestry. While dental traits are not as diagnostic as craniometrics, they can be useful in certain contexts, such as when DNA samples do not produce results and cranial remains are too fragmented to be analyzed. The remains of individuals recovered in an unmarked cemetery at the Dozier School for Boys were highly degraded and mostly consisted of juveniles, leaving limited options for ancestry estimation. The teeth of these individuals, however, were mostly preserved, providing opportunity to estimate ancestry from dental remains. Using rASUDAS, ancestry estimates of 41 individuals were assessed using non-metric dental traits. To reflect the demographics of the Dozier School, the individuals were compared to the Sub-Saharan African (SSA) and Western Eurasian (WE) samples. Twenty-five individuals were classified as SSA and 16 were classified as WE. Posterior probabilities of these classifications ranged from 0.5319 to 0.9985. The overall results are relatively consistent with the known

demography of the site, suggesting that these traits are useful to biological anthropologists working with degraded remains. Caution should be exercised, however, as many of the posterior probabilities were low, and human variation and gene flow may cause the misclassification of some individuals.

### Primate femoral condyle curvature: linking shape and locomotion

ADAM D. SYLVESTER

Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

Reconstructing locomotor repertoires remains a central goal of fossil primate research. The chondral modeling theory, which argues that joint surface curvature reflects loading patterns during ontogeny, provides an opportunity for further elucidating the relationship between skeletal form and locomotor function, strengthening our interpretations of fossil material. Here I quantify joint surface curvature of the femora condyles of four species of hominids, demonstrating that patterns of curvature reflect both locomotor behaviors and joint kinematics during walking.

Surface scans of femora of *Homo sapiens* (n = 40), *Pan troglodytes* (n = 35), *Gorilla gorilla* (n = 25), and *Pongo pygmaeus* (n = 35) were created, and the mechanical axis and the knee flexion/extension axis were identified. Profile outlines (from a lateral perspective) of both femoral condyles were extracted, and curvature was quantified as the radius of curvature along the profile curve. The position of the region of lowest curvature was quantified on each condyle as an angle relative to the mechanical axis. Knee kinematics during normal walking were obtained from the literature and compared with morphological values.

*Pongo* femora were unique among the primates because they evince a relatively constant radius of curvature across the condyles, a result expected based on their arboreal behaviors. The more terrestrial primates, particularly *Homo* and *Pan*, show distinct areas of low curvature which correlate with knee angles used during normal walking. These results suggest that articular curvature offers an additional avenue for reconstructing the locomotor behaviors and kinematics of fossil primates.

*This project was supported by the Leakey Foundation*

### Suicidal Behavior as a Costly Signal of Apology

KRISTEN L. SYME and EDWARD H. HAGEN  
Anthropology, Washington State University

Evolutionary medicine contends that physiological and psychological states traditionally categorized as pathologies in Western medicine might represent adaptations entailing benefits

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that become apparent only after analyzing these conditions within a Darwinian framework. The present study tested a novel evolutionary model of suicidal behavior (SB) against the ethnographic record. In a previous study, the researchers tested two evolutionary models of SB: the inclusive fitness model and the bargaining model (BRM), a game theoretic model based on costly signaling theory that sees SB as a credible signal of need in the face of a fitness threat. The researchers operationalized the two models into a set of variables, and two independent coders coded 472 texts from the Human Relations Area Files. While the BRM was well supported by the data, there were recurrent themes that did not map on to either model such as shame and accusations of wrongdoing. The researchers reformulated the BRM in light of these variables to create the costly apology model, a sub-type of the BRM that frames SB as a sincere signal of apology. Two independent coders recoded the same extracts for these variables. Data analyses supported the costly apology model of SB. First, many of the model's variables were moderately represented in extracts and cultures. Secondly, a non-negative matrix factorization showed that the theoretical variables formed distinct clusters, occupying unique components. The researchers demonstrate that SB might represent an adaptive behavioral response to highly threatening situations, the alleviation of which necessitates assistance from social partners.

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### Estimation of ancestry in non-adults

AMY L. SZEN

Anthropology, SUNY Binghamton

As skeletal biologists are aware, the creation of a biological profile is one of the most important steps when analyzing remains that may be of medico-legal significance. This is due to the fact that social "race," while not always tied directly to ancestry, is often linked to the phenotypic expression of one's ancestry. The biological profile is no less important when analyzing non-adult remains. Like adult skeletal remains there are a number of methods that can be used to estimate some of the aspects of the biological profile from non-adult skeletal remains. Unfortunately, a method for estimating ancestry is not among them. Additionally, there appears to be a very limited amount of research done on attempting to create these methods or standards for estimating ancestry in non-adult individuals, particularly when compared to the extensive literature on estimating ancestry in adults. This project utilized the Hamann-Todd, Terry and National Museum of Natural History collections to examine if ancestrally related craniofacial differences could be metrically assessed in non-adult samples, and at what point in development these differences occur. Craniofacial measurements from Howells

definitions were taken using a 3D digitizer (n=169) (ages: infant to ~21 years). Total shape for each age category was defined using factor analysis, while group difference was calculated using MANOVA. Preliminary analysis shows only a significant relationship in nasal breadth (sig. .70) between the ages of 10 and 12. These preliminary results indicate that ancestrally related craniofacial differences may not be visible metrically until the non-adults enter pubescence.

### Sacral variability in tailless species: *Homo sapiens* and *Ochotona princeps*

ROBERT G. TAGUE

Geography and Anthropology, Louisiana State University

*Homo sapiens* is variable in number of sacral vertebrae, and this variability can lead to obstetrical complication. This study uses the comparative method to test the hypothesis that sacral variability in *H. sapiens* is associated with absence of a tail. Three species of lagomorphs are studied: *Ochotona princeps* (n = 271), which is tailless, and *Lepus californicus* (n = 212) and *Sylvilagus audubonii* (n = 207), which have tails. The directional hypothesis is that *O. princeps* will have higher variability in number of sacral vertebrae than *L. californicus* and *S. audubonii*. Results fail to reject the hypothesis: 1) Diversity Index for number of sacral vertebrae is higher in *O. princeps* (0.49) than *L. californicus* (0.25) and *S. audubonii* (0.26), and 2) *O. princeps* has significantly higher frequency of individuals with the nonmodal number of sacral vertebrae compared to *L. californicus* and *S. audubonii*. *H. sapiens* (n = 1,030; individuals of age 20 to 39 years) shows an identical Diversity Index (0.49) with *O. princeps*. Compared to tailed *L. californicus* and *S. audubonii*, tailless *H. sapiens* and *O. princeps* show higher propensity for assimilation of the first caudal vertebra with the sacrum, albeit the prevalence rate is lower in *H. sapiens* than *O. princeps*. The prevalence rate of this assimilation is lower in *H. sapiens* because the elongated sacrum shortens the posterior sagittal diameter of the pelvic outlet, thereby reducing overall size of the outlet. This change can be obstetrically hazardous.

### Vulnerability: Going Beyond the Physical to the Spiritual to Understand Indigenous Health in the Amazon

PAULA S. TALLMAN

Keller Science Action Center, The Field Museum of Natural History

Introduction: Vulnerability can be conceptualized as a host of factors intersecting to produce risk for poor outcomes. In 2013, the author developed and piloted the "Index of Vulnerability", which combined measures of food insecurity, water insecurity, access to healthcare, social status,

and social support and predicted a range of health outcomes among 250 Awajún men and women living in the Peruvian Amazon. In 2015, the author hosted a conference in Lima, Peru to discuss these results and the state of vulnerability research in the Amazon with representatives from indigenous communities, researchers, and policy-makers.

Results: In this poster, the author discusses the implications of a presentation given at this conference by a Kukama representative from the Peruvian Amazon that sheds light on why indices and physical measures do not fully capture the vulnerability of indigenous populations to ecosocial changes. Specifically, this representative explained that community concerns over the development of a *hydrovia* (river highway) on the Marañón River go beyond food and water insecurity. For the Kukama, the river is where their deceased loved ones reside and to contaminate the river is to threaten their entire spiritual cosmology.

Conclusion: While quantitative measures have an important role to play in vulnerability research and associated policy, these approaches do not address how ecosocial changes impact spiritual health. Anthropologists are uniquely positioned to go beyond the physical, to the spiritual, to provide a more holistic and realistic assessment of health in indigenous communities in the Amazon and beyond.

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### Cranial and Pelvic Nonmetric Sexual Dimorphism in Modern Japanese and Thai Individuals

SEAN D. TALLMAN

Department of Anatomy and Neurobiology, Boston University

Sex is one of the most important components of the biological profile as it dictates the methods used in the estimation of age, ancestry, and stature. While sex can be accurately estimated through the measurement of numerous cranial and postcranial elements, sex is often determined through the visual assessment of robust or gracile pelvic and cranial features. Further, it is clear that differences in sexual dimorphism exist between populations; however, little work has tested the efficacy of nonmetric-scoring systems on Asian populations. This study examines cranial (mastoid process, nuchal crest, glabella, supraorbital margin, mental eminence) and pelvic (ventral arc, subpubic concavity, ischiopubic ramus, sciatic notch, preauricular sulcus) nonmetric sexual dimorphism in 1,397 Japanese and Thai individuals, 17 to 96 years old. The results indicate that while some population differences exist between the Japanese and Thai, the inclusion of population in statistical models

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failed to contribute to the models' performances. Customized binary logistic regression equations and CHAID decision trees resulted in pelvic correct classification rates of 86-98% and cranial correct classification rates of 73-92%. However, the nonmetric sex assessment methods developed on non-Asian populations produced lower correct classification rates and higher sex biases when applied to the Japanese and Thai samples, likely due to divergent population histories and micro-evolutionary processes. Additionally, while age and intraobserver error minimally affect the nonmetric traits, secular change may influence their expression, thereby complicating their use in sex assessment. The findings of this research underscore the importance of understanding the factors that contribute to nonmetric variability.

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### **Synchrotron x-ray microtomography for non-destructive adult age-at-death estimation: visualizing cementum annulations in a historical human assemblage**

NANCY TANG<sup>1</sup>, ADELIN LE CABEC<sup>2,3</sup>, SIMON HILLSON<sup>4</sup> and PAUL TAFFOREAU<sup>3</sup>

<sup>1</sup>CemeNTAA, ANR, <sup>2</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>3</sup>ID19 Beamline, European Synchrotron Radiation Facility, <sup>4</sup>Institute of Archaeology, University College London

Accurate age-at-death estimation remains important when reconstructing life history profiles for archaeological populations. Challenges facing these estimations in adults include highly individualized physiological manifestations of degenerative processes upon which many ageing methods are based and diagenetic changes affecting the skeletal or dental components. Tooth cementum is deposited throughout life in incremental lines and has been used as an age-at-death indicator. A limited number of studies examine cementum annulations in known-age archaeological human material, and a method to assess cementochronology in humans non-destructively does not currently exist. Here we present a pilot study aiming to image cementum annulations by propagation phase contrast synchrotron x-ray microtomography in 21 human canines, ranging between ages 20 to 81 years, from an 18<sup>th</sup> to 19<sup>th</sup> century known-age collection excavated at St. Luke's Church in London, England. We scan transverse segments of cementum in the apical region of the middle third of the root. We cut virtual transverse sections from these scans and use these sections to perform a blind count of annulations. Estimated age shows a statistically significant linear relationship with age-at-death ( $r^2=0.59$ ,  $p<0.01$ ). Variation between two observers using

a data subset shows a mean absolute difference of 4.3 years, indicating high agreement using the intra-class correlation test ( $ICC=0.96$ ,  $p<10^{-6}$ ). Most ages are underestimated, and accuracy appears to decrease with increasing decade of life. With further refinement of scanning parameters this approach presents a promising alternative to current destructive methods of cementum annulation analysis.

*We thank the European Synchrotron Radiation Facility for their in-house beamtime access.*

### **Are the socially recognized ethnic groups of northern Pakistan meaningful biological entities for reconstruction of population histories? A dental morphology investigation**

MUHAMMAD TARIQ<sup>1</sup>, HABIB AHMAD<sup>2</sup> and BRIAN HEMPHILL<sup>3</sup>

<sup>1</sup>Department of Genetics, Hazara University, <sup>2</sup>Vice-Chancellor's Office, Islamia College, <sup>3</sup>Department of Anthropology, University of Alaska, Fairbanks

The biological relevance of ethnic identifications of ethnic groups residing in northern Pakistan is largely unknown. Oral traditions suggest little intermarriage between such groups. This study employs 17 tooth-trait combinations of the Arizona State University Dental Morphology System among 689 individuals of five ethnic groups (Jadoons Tanolis, Gujars, Syeds, Yousafzais) from Buner and Swabi Districts, the latter three of which were sampled in both districts. These data were contrasted with 27 samples encompassing 3,185 prehistoric and living individuals from Pakistan, peninsular India, and Central Asia, including additional geographically distinct samples of Gujars, Syeds and Tanolis. Intersample affinities based upon pairwise MMD values were examined with neighbor-joining cluster analysis (NJ) and multi-dimensional scaling (MDS).

Results are consistent across both data reduction techniques as NJ and MDS identify geographically distinct ethnic group samples of Gujars, Tanolis, Wakhis, and Yousafzais as possessing closest affinities to the other sample(s) of that same ethnic group. However, this pattern does not hold for Awans and Syeds. Such results suggest that for most ethnic groups of Khyber Pakhtunkhwa Province, ethnic identity does equate with biological identity and hence, examinations of such socially recognized groups are useful for the reconstruction of population histories. By contrast, the Awan and Syeds exceptions are likely the consequence of occupational specialization as zamindars and claims of social superiority, respectively. Consequently, social identifications such as these are meaningless for tracing biological origins.

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### **Diverse Patterns of Neanderthal Introgression in Western Asia**

RECEP O. TASKENT<sup>1</sup>, DUHA ALIOGLU<sup>2</sup>, EVRIM FER<sup>3</sup>, HANDAN M. DONERTAS<sup>2</sup>, MEHMET SOMEL<sup>2</sup> and OMER GOKCUMEN<sup>1</sup>

<sup>1</sup>Department of Biology, SUNY at Buffalo, <sup>2</sup>Department of Biology, Middle East Technical University, Turkey, <sup>3</sup>Molecular Biology and Genetics, Istanbul Technical University, Turkey

Neanderthals contributed genetic material to the ancestors of present-day Eurasians via multiple introgression events. The initial introgression event most likely occurred in Western Asia during the out-of-Africa migrations of modern humans. Our earlier analyses suggest that Western Eurasian populations show highly variable patterns of Neanderthal introgression in their genomes. We hypothesize that this variation could be related to more recent, population-specific migrations. Indeed, it has previously been shown that Western Asian populations show significant genetic structure, essentially creating a quilt pattern, which contrast with the clinal patterns of genetic variation observed in Europe. To investigate whether such genetic structure can explain different levels of Neanderthal introgression among Western Asian populations, we conducted S\* statistics based analyses of dozens of genomes and identified the haplotypes introgressed from Neanderthals. We then specifically analyzed introgression patterns in Turkish genomes as compared to those in other Eurasian genomes. Our results revealed distinct introgressed haplotypes that show more than expected population differentiation between Turkish genomes and those of other Eurasian populations. Furthermore, we identified introgressed haplotypes in the Turkish population, which are absent in other European populations. Based on further population genetics analyses, we argue that complicated population histories of Western Asian populations along with a population-specific adaptive forces are likely responsible for the complex Neanderthal introgression patterns observed across Western Asia.

*Omer Gokcumen's start-up funds from University at Buffalo Research Foundation*

### **Distinguishing locomotor adaptation of non-human primates and hominoids using ulnar diaphyseal curvature**

CATHERINE E. TAYLOR<sup>2</sup> and YOHANNES HAILE-SELASSIE<sup>1,2</sup>

<sup>1</sup>Physical Anthropology, Cleveland Museum of Natural History, <sup>2</sup>Anthropology, Case Western Reserve University

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Morphology of the primate forearm plays an essential role in studying locomotor adaptation in hominoids. Length ratios, proximal/distal end measurements of the arm bones, and particularly diaphyseal curvature of the ulna have been informative proxies in this study. Ulnar diaphyseal curvature is usually measured as "the maximum distance from the posterior-most margin of the bone and a line drawn between two inflexion points on the posterior margin of the diaphysis, one at the level of the radial notch and the other at the level of minimal distal circumference". In this study, diaphyseal curvature of extant non-human primates (n=165 specimens from 11 genera) and fossil hominoid ulnae is measured using a new method developed by the authors. This method measures ulnar curvature as the maximum distance between the anterior margin of the diaphysis and a line drawn from the proximal, anteriormost point of the radial notch to the most distal point of the diaphysis. This measurement is taken from photographs in which ulnae are placed so that the long axis of the radial notch is parallel to the horizontal surface. The curvature measurements taken using the new method are supplemented by 13 other ulnar measurements. Principal component analyses of the combined dataset have yielded results that distinguish genera based on locomotor adaptation and evolutionary relatedness better than the traditional diaphyseal curvature measuring technique. Therefore, this new method might be a better way of using ulnar diaphyseal curvature in identifying locomotor adaptation in a wider range of extinct hominoids.

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### Big Classes, Small Budgets, and Osteometric Lab Equipment: Is cost Commensurate with Quality?

LINDA L. TAYLOR<sup>1</sup>, MONICA FARALDO<sup>2</sup> and GABRIEL A. CARDENAS<sup>3</sup>

<sup>1</sup>Anthropology, University of Miami, <sup>2</sup>Anthropology, University of Miami, <sup>3</sup>Public Health Sciences, University of Miami

The growing popularity of hands-on osteology and forensic courses has resulted in increased need for assessment equipment for teaching labs. Purpose-built equipment can be costly compared to student-level equivalents. Most institutions are challenged to balance cost, quality, and quantity. In this paper, we report the results of our efforts to meet this challenge by comparing data accuracy, ease of use, and durability, between expensive equipment (EE) and cost effective alternatives (CE). Our goal was student data accuracy within  $\pm 2$ mm of the instructor's data for all variables. EE (\$625) and CE (\$75) osteometric boards were used to measure length of long bones (6 femora, 6 humeri) by the instructor, 20 inexperienced and 20 experienced students. EE digital sliding

calipers (\$160) and CE equivalents (\$35, \$10) were used to measure head and midshaft diameter on the same set of long bones by all users. Data for all 3 variables, as assessed by both groups of students, met the accuracy target goal for comparable data gathered by the instructor; inexperienced mean was  $\pm 2$ mm of the instructor (range = 1-4mm), experienced students scored  $\pm 1$ mm (range = 0-3mm). Experienced students accomplished the tasks more quickly and some expressed preference CE boards and calipers. None of the equipment failed, although one CE board required minor in-house repair within 1 month of purchase. Our study suggests that CE alternatives are as accurate, easy to use, and durable as EE instruments in our lab setting, giving us significant savings per unit purchased.

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### A large modern Southeast Asian skeletal collection from Thailand

NAWAPORN TECHATAWEEWAN<sup>1</sup>, PANYA TUAMSUK<sup>1</sup>, YANYONG TOOMSAN<sup>1</sup>, MALIVALAYA NAMKING<sup>1</sup>, PATTAMA AMARTTAYAKONG<sup>1</sup>, SOMSIRI RATANASUWAN<sup>1</sup> and NANCY TAYLES<sup>2</sup>

<sup>1</sup>Anatomy, KHON KAEN UNIVERSITY, <sup>2</sup>Anatomy, University of Otago

The Khon Kaen University Human Skeleton Research Centre in Thailand has a collection of 745 modern North-eastern Thai (Isan) skeletons of known age and sex derived from bodies bequeathed to the Department of Anatomy in the Medical Faculty of the university since 1979. This poster describes the collection and addresses the question of whether or not, for research purposes, it may be representative of populations of Isan or of wider mainland Southeast Asia. The collection consists of two-thirds males and one-third females, almost all adults, aged from 20 to 109 years. Average age at death remained unchanged at 62 years during the 35 years of accumulation of the collection but during this period Thailand went through a significant economic transformation. Apart from the unbalanced sex ratio, the consistent average age at death of the collection shows that is not representative of decedents in the region during this period, as it is initially too high and ultimately too low in comparison with contemporaneous Thai populations. Many body donors are farmers. Some characteristics of the skeletons may not reflect skeletal morphology of current populations in areas of Thailand or elsewhere in Southeast Asia where the economic revolution has had a significant effect on lifestyle, but as the largest and most representative collection in Southeast Asia, the skeletons are an excellent representation of the genetics and biology of the rice farmers who form a large proportion of the regional population, and much of Southeast Asia where agriculture dominates the economy.

### I Did it My Way!: Three Nocturnal Lemur Species show Intraspecific Inter-individual Variation when Solving a Multi-destination Route

JULIE A. TEICHROEB<sup>1,2</sup> and ALEXANDER Q. VINING<sup>2,3</sup>

<sup>1</sup>Anthropology, University of Toronto Scarborough,

<sup>2</sup>Evolutionary Anthropology, Duke University,

<sup>3</sup>Anthropology, University of California Davis

Movement ecology seeks to understand the processes underlying animal movements. Studies are often done at the group, population, or species levels, but these represent averaged individual movement decisions. Few studies have examined individual differences in movement strategies in primates but intraspecific variation may reflect age, sex, genetic, or other differences. We examined how three nocturnal lemur species, gray mouse lemurs (*Microcebus murinus*), fat-tailed dwarf lemurs (*Cheirogaleus medius*), and aye-ayes (*Daubentonia madagascariensis*), solved a multi-destination route at the Duke Lemur Center. At least six individuals of each species were tested on an array of six targets with 720 possible routes. Trials began when the food at one target was eaten and ended when all bait was consumed. We noted order of site visitation (including re-visits), speed, and behavior during trials. Individual variation in ability, paths, distance traveled, learning over time, speed, and behavior occurred in each species. Dwarf lemurs showed the least variability and on average the greatest ability to solve the route. Mouse lemurs showed the most variability - with some individuals unable (or unwilling) to do the task, an individual that was the worst performer overall, and another that was the best performer overall. Aye-ayes showed patterns of variability that may be attributed to age and sex. Two older females (>30 years) were slow but direct in their movements, while both males in the sample went through the route quickly but showed repetitive paths. These results underscore the problems of averaging species-wide movement patterns from individual data.

*Duke University, University of Toronto*

### Adaptation and Resiliency in Hunter-gatherers: Approaches to Environmental Variation in Prehistoric Hunter-gatherers of the Jomon Period

DANIEL TEMPLE

Sociology and Anthropology, George Mason University

Bioarchaeology frequently relies on cultural ecological paradigms and comparisons of lesion frequencies to evaluate culture change in hunter-gatherers. This approach has the unintended consequence of framing hunter-gatherer culture in a progressivist context. Resilience theory incorporates endurance into the experience of cultural

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transition, while paleodemographic methods explain how stress experiences impact life histories. This study integrates paradigms from human behavioral ecology and resilience theory to human skeletal remains associated with the Middle and Late/Final Jomon culture to evaluate culture change at both the macro- and micro-level. The Yoshigo and Inariyama cemeteries include human remains from two separate occupations of the sites over a short temporal sequence (3100-2300, 2600-2300 BP), while Ota (5000-4000 BP) and Tsukumo (ca. 3000 BP) reflect adjacent coastal sites with occupations dated before and after climatic cooling. Carious lesion frequencies, the relationship between stature and survivorship, and patterns tooth extraction were used as proxies for diet, stress, and embodied indicators of identity. Carious lesion frequencies increased after climatic cooling, but do not change over the short-term. No association between stature and survivorship was found, and stature declines after climatic cooling, but remains consistent in the short-term. Tooth extraction increases in frequency following climate change, and different teeth are extracted during later periods of site occupation. These results demonstrate variation in the manifestation of biocultural variation over long and short-term periods of cultural transition. An approach that emphasizes adaptation and endurance may best capture the broader human experience associated with culture change.

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### Adaptive plasticity in the masticatory apparatus: inferences for form, function, and fossils

CLAIRE E. TERHUNE<sup>1</sup>, ADAM D. SYLVESTER<sup>2</sup>, SUSAN COINER-COLLIER<sup>3</sup>, JEREMIAH E. SCOTT<sup>4</sup>, KEVIN R. MCABEE<sup>3</sup> and MATTHEW J. RAVOSA<sup>5</sup>

<sup>1</sup>Department of Anthropology, University of Arkansas,

<sup>2</sup>Center for Functional Anatomy and Evolution, Johnson Hopkins School of Medicine, <sup>3</sup>Department of Biological Sciences, University of Notre Dame,

<sup>4</sup>Department of Anthropology, Southern Illinois University, <sup>5</sup>Departments of Biological Sciences, Aerospace & Mechanical Engineering, and Anthropology, University of Notre Dame

Understanding bone functional adaptation is critical for reconstructing behaviors of and inferring evolutionary relationships among fossil species. Though form-function relationships are most frequently examined in an evolutionary framework, the mediating role of loading environment during ontogeny plays an important role in determining the expression of adult form. Moreover, different anatomical regions and analytical scales may reveal disparate patterns, reflecting a complex interplay of adaptive plasticity and evolutionary adaptation. In the masticatory apparatus, previous experimental manipulations of diet have

successfully induced changes in skeletal shape exceeding differences observed among primate genera.

Here we examine micro- and macro-structural differences in skull form in an experimental group of white rabbits (*Oryctolagus cuniculus*) raised for a year on diets that varied in mechanical properties. We employ sliding semilandmarks to locate multiple volumes of interest deep to the articular surface of the mandibular condyle, and we assess trabecular thickness and spacing, anisotropy, and bone volume fraction. We compare differences among experimental groups of rabbits to differences observed within and among primate species.

Results reveal that rabbits raised on a mechanically challenging diet (hay+pellets) have significantly thicker condylar trabeculae and higher bone volume fraction relative to controls fed a pellet-only diet. Interestingly, these phenotypic differences are often as great as or exceed those observed between primate species with variable diets. These results suggest that adaptive plasticity is fundamental to consider when assessing fossil shape variation and may require reassessment of taxonomies and phylogenies, as well as a reconsideration of the form-function relationship in the masticatory apparatus.

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### Childhood Survival and Perinatal Stress: A Case Study from Northern Peru

JACLYN A. THOMAS, DANIEL H. TEMPLE and HAAGEN D. KLAUS

Sociology and Anthropology, George Mason University

This study explores the association between the presence of crypt fenestration enamel defects (CFED) and childhood survival at two postcontact sites from the north coast of Peru: Eten (A.D. 1533–1620) and Mórrope (A.D. 1536–1750). CFEDs, are focal, plane-form defects that manifest as pits of varying sizes in the enamel with occlusal dentine involvement. These defects form almost exclusively on the facial aspect of the mandibular deciduous canines and their etiology suggests that they are likely to be a result of dietary deficiencies in the perinatal environment. CFEDs were identified in the deciduous mandibular canines among infants and children from Eten (n = 42) and Mórrope (n = 63). Kaplan survival analysis was performed on each sample to ascertain if the presence of these defects was associated with a greater mortality risk between infancy and childhood. CFED presence or absence was listed as the factor and age-at-death was the time series variable. The 95 percent confidence intervals for the CFED presence and absence groups overlapped in the Eten (2.51-4.06, 2.26-3.70) and Mórrope samples (1.75-2.67,

1.41-2.40). This result suggests no differences in survivorship at either site in relation to the presence or absence of CFED. Two explanations are possible. First, it is possible that the energetic trade-offs associated with surviving the event that produced CFED did not elicit future trade-offs with respect to childhood mortality. It is also possible that the postnatal cultural environment mitigated the energetic trade-offs associated with surviving events that produce CFED, and thus, acted to mitigate childhood mortality.

### NAGPRA in Practice: Moving from the Classroom to Collaboration

JAYNE-LEIGH THOMAS  
NAGPRA, Indiana University

Generally a bioanthropology student's first encounter with NAGPRA is as a passing mention at the end of their textbook chapter, focusing on the Kennewick Man case. Few students receive more detailed training in how to *do* NAGPRA, and even fewer have the opportunity to work directly with descendant communities. Research data collected by the 2015 NSF Learning NAGPRA Project indicates strong student interest in working with descendant communities and repatriation specialists. Experiences with repatriation personnel across the country have provided insights into the process of consultation and how to develop collaborative research projects which are mutually beneficial to both parties. Working directly with tribal communities has shown that tribes are interested in community-based, scientific research, provided the opportunity is available for input and open discussion. The next generation of bioanthropologists must obtain experience collaborating with interested stakeholders so that their research not only remains relevant to those outside of academia, but also so that it addresses and incorporates the perspectives of the individuals whose ancestors are the focus of study.

### Accuracy Rates of Ancestry Estimation by Forensic Anthropologists Using Identified Forensic Cases

RICHARD M. THOMAS<sup>1</sup>, CONNIE PARKS<sup>2</sup> and ADAM RICHARD<sup>3</sup>

<sup>1</sup>Forensic Anthropology Program, FBI Laboratory, <sup>2</sup>Counterterrorism and Forensic Science Research Unit, FBI Laboratory, <sup>3</sup>Terrorist Explosive Device Analytical Center, FBI Laboratory

A common task in forensic anthropology involves the estimation of the ancestry of a decedent based upon their skeletal remains using a number of morphological and metric techniques by exploiting variation between groups from different geographic regions. Although a growing body of literature exists reporting research-based ancestry estimation accuracy rates, historical reviews and assessments of practitioner

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accuracy rates from operational casework with confirmed ancestry are rare. The research described in this presentation used individuals of known ancestry, based upon subsequent positive identification, from 99 actual forensic cases to develop "real-life" accuracy rates for ancestry estimations in order to: (i) determine the empirical accuracy rate of anthropological ancestry assessment for a sample of contemporary forensic casework with identified ancestry and (ii) investigate any differences in empirical accuracy rates based on practitioner education and certification level, demographic cohort, and date of analysis.

The overall rate of correct ancestry estimation from these cases is 90.9%, which is comparable to most research-derived rates and those reported by individual practitioners. Statistical tests showed no significant difference in accuracy rates depending on examiner education level or on the estimated or identified ancestry. More recent cases showed a significantly higher accuracy rate. The incorporation of metric analyses into the ancestry estimate in these cases led to a higher accuracy rate. Despite this level of success, forensic anthropologists should be conservative and conscientious about how the results of ancestry estimation are communicated to avoid the possibility of individuals being wrongfully excluded as a possible match to unidentified remains.

### A preliminary study of primate abundance in East Turkana collection areas relative to outcrop size

BENJAMIN THOMPSON<sup>1</sup>, JULIA ARENSON<sup>2,3</sup>, MARYSE BIERNAT<sup>4</sup>, W. ANDREW BARR<sup>5</sup>, JONATHAN REEVES<sup>5</sup>, DAVID R. BRAUN<sup>5,6</sup> and ASHLEY HAMMOND<sup>5</sup>

<sup>1</sup>Applied Forensic Sciences, Mercyhurst University, <sup>2</sup>Department of Anthropology, City University of New York, <sup>3</sup>New York Consortium of Evolutionary Primatology, NYCEP, <sup>4</sup>Department of Anthropology, Smithsonian Institution, <sup>5</sup>Center for the Advanced Study of Human Paleobiology, Department of Anthropology, George Washington University, <sup>6</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

Paleoenvironmental reconstructions are key for understanding hominin evolution but are almost certainly affected by collection biases favoring hominins and primates. The objectives of this study are to (1) evaluate primate abundance in a subset of collection areas in the Koobi Fora Formation using the Turkana Basin Paleontology Database (TPD); (2) test whether systematic surface surveys in Koobi Fora yield similar estimates of primate abundance as the TPD; and (3) evaluate whether primate abundance differs substantively between areas when controlling for outcrop size.

We conducted systematic surface surveys in six collection areas in East Turkana (Areas 102, 103, 105, 123, 131, 6A). Faunal abundance values from surveys and the TPD were converted into percentages separately for each area. Outcrop size was measured in a subset of these areas (Areas 6A, 8, and 105) by digitally segmenting outcrops on satellite imagery and georeferenced maps in ESRI ArcMap 10.2.

In the TPD, all primates in East Turkana comprised ~28% of all mammalian fauna, with hominins comprising ~3%. In contrast, <1% of mammals in the survey data were identifiable as primate. The TPD abundance values were variable between areas, with Area 6A showing an unusually high level of hominin abundance (15.9% of fauna) and the highest density of hominins (1.9 hominins/km<sup>2</sup> in total collection area but 4.9 hominins/km<sup>2</sup> of outcrop). While reported primate abundance data certainly reflect some taphonomic and collection biases, these preliminary data suggest that there may be real paleoecological signatures detected by local differences in primate frequency.

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### Craniosynostosis and Inheritance: A Bioarchaeological review in the Middle Tennessee River Valley

BRANDON S. THOMPSON

Office of Archaeological Research, The University of Alabama

Beginning in 2015 as part of an ongoing multi-year study, the University of Alabama Office of Archaeological Research and Department of Anthropology have analyzed more than 3300 sets of osteological remains from nearly 50 archaeological sites. Located in north Alabama within the Middle Tennessee River Valley, these sites were excavated in the late 1930s and early 1940s by the Works Progress Administration prior to the construction of hydroelectric dams. This study focuses on the occurrence of craniosynostosis, a condition defined by the premature fusion of one or more cranial sutures with origins that are idiopathic, environmental, inherited, and related to gene mutation. Documented frequencies of craniosynostosis indicate that while isolated cases occur throughout the river valley at the intersite level, a statistically significant number of cases occur at the intrasite level within the Middle Woodland Copena culture at Site 1Ms91. By eliminating environmental and human driven factors, such as deliberate cranial modification through cradle boarding, these findings provide evidence for inheritance and familial descent as the origin for craniosynostosis at this locus. Additionally, these data offer insight into population movement and geographic isolation within the region.

### Sexual Dimorphism in Absolute and Relative Sizes of Pubis Dimensions from a Documented Human Osteological Collection

BRITTANY N. THOMPSON and FRANK L. WILLIAMS  
Anthropology, Georgia State University

Sexual dimorphism of the pelvis is strongly manifested in pubic bone morphology whereby females exhibit a mediolaterally broader and more square-shaped pubic body and males present a pubis which is mediolaterally truncated and more triangular in shape. In order to evaluate dimorphism in absolute and relative size dimensions of the pubic bone, a total of 264 individuals (131 females and 133 males) were examined at the Forensic Anthropology Center of the University of Tennessee, Knoxville, and eight linear dimensions on the pelvis were obtained. Patterns of absolute size differences suggest females are significantly larger for pubic body length and pubic body width whereas males are significantly larger for pelvic dimensions not involving the pubis. For relative size differences, females are significantly larger in pubic length and width as well as ilium breadth dimensions whereas males are significantly larger for pubic body height and ilium height. Jack-knifed classification rates from a discriminant function analysis indicate that 92% of individuals are correctly classified with respect to sex. A principal components analysis yields two axes with eigenvalues greater than one accounting for 64.9% of the variation. The first axis, explaining 45.4% of the variance, separates individuals on the basis of size regardless of sex, whereas the second axis, describing 19.5% of the variation, separates females from males on the basis of the larger ilium measurements of males and the larger pubis dimensions of females. Pubis length and breadth dimensions are proposed to be robust yet underutilized indicators of sex membership in unknown individuals.

### New Estimates of Body Mass for "Giant" Subfossil Lemurs using Phylogenetic Regressions and Implications for Relative Brain Size, Life History and Risk of Extinction

KATHARINE ETH. THOMPSON<sup>1</sup> and WILLIAM JUNGERS

<sup>1</sup>Anthropology, Stony Brook University, <sup>2</sup>Association Vahatra, Antananarivo, Madagascar

Body mass estimates for extinct animals are used to inform a number of hypotheses and analyses regarding behavioral ecology, extinction risk and locomotor mode. The accuracy and reliability of body mass estimates are important starting points in any analysis. Several studies have shown that long bone length and cross-section geometry are both highly correlated with body mass in primates and other vertebrates. With respect to geometry, Jungers et al. (2008) provided body

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mass estimates for many of Madagascar's extinct subfossil lemurs using femoral and humeral mid-shaft cortical area. However, this study did not account for the effects of species relatedness within and between clades. Our study revises these widely applied body mass estimates using a new sample of subfossil lemur long bones and phylogenetically informed methods. New and revised estimates of body mass are consistently smaller than previously suggested.

### Pelvic height, lumbar entrapment, and their effects on upper body stability during bipedalism

NATHAN E. THOMPSON<sup>1</sup>, MATTHEW C. O'NEILL<sup>2</sup> and BRIGITTE DEMES<sup>3</sup>

<sup>1</sup>Department of Anatomy, NYIT College of Osteopathic Medicine, <sup>2</sup>Department of Basic Medical Sciences, University of Arizona College of Medicine, <sup>3</sup>Department of Anatomical Sciences, Stony Brook University

Compared to modern humans, African apes are characterized by tall iliac blades, narrow sacra, and a short lumbar vertebral column. These characteristics are thought to engender morphological rigidity of the trunk, potentially limiting the ability for upper body stabilization in the sagittal plane during bipedalism. Here we test this hypothesis with 3-D kinematic data on trunk motion during bipedalism in humans (n=10) and chimpanzees (n=2). Marker triads defined trunk segments (pelvis, lumbar region, thorax) and were used to calculate sagittal plane segment motion (tilt) relative to a global coordinate system.

Humans and chimpanzees displayed similar patterns and timings of lumbar and thoracic tilt, while pelvic tilt differed between species. In chimpanzees, all trunk segments tilted either anteriorly or posteriorly together, whereas in humans the thorax and lumbar region tilted posteriorly when the pelvis tilted anteriorly. Humans also displayed smaller ranges of motion (RoM) of all trunk segments compared to chimpanzees (P<0.001), and (unlike chimpanzees) displayed an attenuation of RoM from caudal to cranial.

These results suggest that a relatively unrestrained lumbar vertebral column in humans allows the upper body independence from pelvic motion in the sagittal plane, with the ultimate result being a fairly stable thorax. Chimpanzees are unable to accomplish this, and the lumbar region and thorax essentially follow pelvic motion. To the extent to which tall iliac blades may have characterized the last common ancestor of *Pan* and *Homo*, reduction in iliac height may have allowed early hominins to walk with greater stability of the upper body.

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### A characterization of nutritional stress among early Medieval subadult females of the central Dalmatian region of Croatia

LINDSEY J. THORSON<sup>1</sup>, VLASTA VYROUBAL<sup>2</sup> and MARIO ŠLAUS<sup>2</sup>

<sup>1</sup>Anthropology, University of Wisconsin Milwaukee, <sup>2</sup>Anthropology Center, Croatian Academy of Arts and Sciences

Early Medieval cemetery burials of the central Dalmatian region of Croatia are typical of Medieval Christian burials. Burials are in regular rows and include few grave goods. However, among the burials of the rural church cemetery site Šibenik-Sv. Lovre (9<sup>th</sup>-11<sup>th</sup> centuries A.D.), jewelry items reflective of female costume items (filigreed earrings, simple hooped earrings and rings), accompany many of the burials, including subadult burials. Among the 55 adults, grave goods positively correlated with females (n=22/30; Fisher's p-value=0.0001): no males (n=0/23) at the site had grave goods. Using a biocultural approach, based on grave-good distribution patterns among adults, it is concluded that nine subadult individuals buried with grave goods represent subadult females. These nine subadult females are all estimated to be over the age of 3-4 years at the time of death; suggesting that the social-age of 'femaleness' is applied during early childhood, after weaning. The subadult females were then compared to the indeterminate-sex children, juveniles and adolescents (n=22) for nutritional health differences. Results show that among the non-infant subadult sample, females are not statistically more likely to have suffered from scurvy, cribra orbitalia, porotic pitting nor hyperostosis. The results suggest that subadult health status at the site is not affected by biological sex (or female-sex), and that any socially applied gender differences do not affect subadult nutritional health. The consequences of the results are discussed in relation to life-course and gender theories.

### Homo naledi's pedal pathologies

ZACH THROCKMORTON<sup>1,2</sup>, BERNHARD ZIPFEL<sup>2</sup>, PATRICK RANDOLPH-QUINNEY<sup>2,3</sup>, EDWARD ODES<sup>2</sup>, KIMBERLY CONGDON<sup>2,4</sup>, JEREMY DESILVA<sup>2,5</sup>, WILLIAM HARCOURT-SMITH<sup>2,6,7</sup> and LEE BERGER<sup>2</sup>

<sup>1</sup>DeBusk College of Osteopathic Medicine, Lincoln Memorial University, <sup>2</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>3</sup>School of Forensic and Applied Sciences, University of Central Lancashire, <sup>4</sup>Department of Anatomy, Touro College of Osteopathic Medicine-Nevada, <sup>5</sup>Department of Anthropology, Dartmouth College, <sup>6</sup>Department of Anthropology, Lehman College, <sup>7</sup>Division of Paleontology, American Museum of Natural History

Pedal pathologies are present throughout the hominin fossil record; at least ten injured hominin feet, ranging from *Ardipithecus ramidus* to *Homo floresiensis*, have been identified and published. We present here further analyses of the *Homo*

*naledi* pedal specimens recovered from the Rising Star Cave, Gauteng, South Africa that contribute to the history of hominin podiatric problems. Specimens U.W. 101-1013 and 1395 are both lesser proximal pedal phalanges that present evidence of healed traumatic fracture; 1013 has a callosity indicating an incomplete, transverse diaphyseal fracture, while 1395's callous encircles nearly the entire circumference, and there is diaphyseal displacement, indicating a complete (or nearly complete), oblique fracture. Both injuries are more consistent with stubbing rather than crushing trauma. U.W. 101-1535 and U.W. 101-1534 are associated left medial and intermediate cuneiforms that exhibit modest osteoarthritic lipping along their complementary dorsal facet rims. While difficult to assess, it is unlikely that any of these pathologies would have been permanently disabling. Interestingly, a survey of published literature on great ape skeletal injuries reveals no known cases of chimpanzees (*Pan spp.*) or gorillas (*Gorilla spp.*) fracturing their pedal phalanges or developing midfoot tarsal osteoarthritis. That fossil hominins, including *Homo naledi*, suffered from pedal pathologies more similar to humans than to chimpanzees and gorillas is unsurprising given our lineage's obligate bipedal locomotor behavior.

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### Socializing by vocalizing: a test of the vocal grooming hypothesis in the gelada (*Theropithecus gelada*)

ELIZABETH T. TINSLEY JOHNSON<sup>1</sup>, NOAH SNYDER-MACKLER<sup>2</sup>, THORE J. BERGMAN<sup>3,4</sup> and JACINTA C. BEEHNER<sup>1,3</sup>

<sup>1</sup>Anthropology, University of Michigan, <sup>2</sup>Evolutionary Anthropology, Duke University, <sup>3</sup>Psychology, University of Michigan, <sup>4</sup>Ecology and Evolutionary Biology, University of Michigan

Social time represents a significant constraint on the number of relationships an individual can maintain, and using vocalizations to socialize could help maintain larger social networks than grooming alone. The vocal grooming hypothesis predicts that vocal exchanges allow conspecifics to maintain ties outside of grooming. In humans, the implication is that language represents an efficient social tool that allows us to maintain large, complex groups. Although this hypothesis is difficult to test directly, two predictions follow: (1) that vocal exchanges are more frequent when individuals are not grooming, and (2) that measures of dyadic sociality predict vocal exchange frequency. Here we use 6 years of behavioral data from a population of geladas living in the Simien Mountains National Park, Ethiopia (28 units, 129 females) to characterize when female geladas vocalize and what predicts vocal exchanges. First, we found that vocalizations occurred more than six times as often when

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females were not grooming compared to when they were grooming. Second, we examined what aspects of female-female relationships predicted the frequency of vocal exchanges. Females that were closer in age and closely related were significantly more likely to engage in vocal exchanges than unrelated dyads or dyads of disparate age (GLMM, age disparity:  $Z$ -value=-12.32,  $p$ <0.001; relatedness:  $Z$ -value=5.93,  $p$ <0.001). In addition, stronger grooming relationships and more time spent in proximity predicted high vocal exchange rates (GLMM, grooming:  $Z$ -value=12.75,  $p$ <0.001; proximity:  $Z$ -value=9.77,  $p$ <0.001). Our results provide initial support for the vocal grooming hypothesis and for the role of vocal exchanges in social bonding.

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### An Analysis of Human Remains from an Inca Ushnu: Polydactylism, Infection, Blunt Force Trauma, and Sharp Force Trauma at Soledad de Tambo, Huachis, Ancash Peru

ANNE R. TITELBAUM<sup>1</sup>, JOSÉ QUEREVALÚ<sup>2</sup>, NILTON RIOS<sup>2</sup> and RICARDO CHIRINOS<sup>2</sup>

<sup>1</sup>Basic Medical Sciences, University of Arizona College of Medicine-Phoenix, <sup>2</sup>Proyecto Qhapaq Ñan, Ministerio de Cultura, Peru

Soledad de Tambo is an Inca site in the northern highlands of Peru. The principal feature of this site is an *ushnu*, a ceremonial platform with a stone lined basin. Typically found in conquered or non-Inca territories, *ushnu* had sociopolitical significance, and provided a place for an Inca administrator to receive conquered people, distribute libations, and perform child sacrifice. They were also utilized for funerary rituals.

Excavation of the platform revealed an undisturbed grave containing nearly complete skeletons of a young adult male (25-30 yo) and a child (0-6 mos). The adult was extended with flexed arms, and the child was placed lateral to the man's thigh. The male is associated with a bronze *tupu*/needle, and he was holding a worn distal end of a deer radius.

While the child did not exhibit apparent pathology, the male demonstrated developmental anomalies including polydactylism; disease processes, including a healed scalp infection and active dental abscesses; antemortem trauma to his right orbit; perimortem trauma to his left orbit, upper left thorax, C1 vertebra, right humerus, and both scapulae; and perimortem sharp force trauma to his abdomen. Although the male appears to have been beaten around the time of death, he was interred with care on the platform of the *ushnu*.

This investigation is one of the first to present an analysis of human remains excavated from an *ushnu*, and as such is an important case for understanding the funerary use of these structures, and gaining insight into Inca imperialism, symbolism, and influence.

*This investigation was supported by the University of Arizona College of Medicine – Phoenix and the Huari Ancash Bioarchaeological Research Project.*

### The costs of conquest: Detecting changing environmental stress in the transition from Iron Age to Roman England

ALEXANDRA R. TOBIN<sup>1</sup> and CHARLOTTE A. ROBERTS<sup>1,2</sup>

<sup>1</sup>Department of Archaeology, Durham University, <sup>2</sup>Wolfson Research Institute for Health and Wellbeing, Durham University

Following the Roman Conquest of Britain in 43 AD, the economy, landscape and indigenous culture of England's southern region experienced an appreciable transition. Urbanization and increased population migration engendered immediate deleterious effects on health in both the existent and migrant communities, as evidenced by changes in stature, demography and the prevalence of infectious disease. The aim of this study was to assess the skeletal evidence of environmental stress experienced during periods of growth and development in individuals dating to the Iron Age (9<sup>th</sup> century BC - 1<sup>st</sup> century AD) and Roman periods (43 AD - 5<sup>th</sup> century AD) in southern England. Multiple non-specific indicators of stress were used in order to test the hypothesis that a decline in health was experienced between these two periods. This included analysis of vertebral neural canal diameters (VNC), and the presence of cribra orbitalia (CO) and dental enamel hypoplasia (DEH). The study considered 48 individuals from the human skeletal assemblages of Maiden Castle, an Iron Age hillfort in Dorset, and the Roman Cemeteries and Suburbs of Winchester, Hampshire. The results of the VNC and DEH analyses suggest that greater levels of environmental stress were experienced during early childhood, and that a decline in health occurred in this region following the Roman Conquest. While the CO data did not yield statistically significant results, the presence of the condition was observed. This study is the first to utilize VNC size as an indicator of non-specific stress in the Iron Age and Roman periods in England.

### A foot for all seasons: Grauer gorillas reveal the effects of phylogeny and function on the evolution of gorilla foot morphology

MATTHEW W. TOCHERI<sup>1,2</sup>, RYAN P. KNIGGE<sup>3</sup>, CALEY M. ORR<sup>4</sup> and KIERAN P. MCNULTY<sup>3</sup>

<sup>1</sup>Department of Anthropology, Lakehead University, <sup>2</sup>Human Origins Program, National Museum of Natural History, Smithsonian Institution, <sup>3</sup>Evolutionary Anthropology Lab, University of Minnesota, <sup>4</sup>Department of Cell and Developmental Biology, University of Colorado School of Medicine

Eastern (*Gorilla beringei*) and western (*Gorilla gorilla*) gorillas are distinguishable from each other based on a number of morphological characteristics, many of which reflect their distinctive ecological habitats. For example, mountain gorillas (*G. b. beringei*) inhabit highland, montane regions whereas western lowland gorillas (*G. g. gorilla*) inhabit lowland, equatorial forests, and as a result, these taxa display more terrestrially and arboreally adapted feet, respectively. However, some grauer gorilla (*G. b. graueri*) populations live in habitats similar to their mountain counterparts while others live in lowland forests similar to those of their more distant relatives in the western lowlands. The habitat range of grauer gorillas thus provides a useful opportunity to examine the effects of phylogeny and function on gorilla foot morphology. Extending upon our previous work on the gorilla talus, we employed three-dimensional geometric morphometric techniques to investigate medial cuneiform shapes among western, mountain, and grauer (lowland and highland) gorillas ( $N=54$ ). After superimposition of landmark and semi-landmark configurations through generalized Procrustes analysis, a between-groups principal components analysis was used to evaluate mean shape differences in the medial cuneiform among gorilla groups. Subsequently, the talus and medial cuneiform were analyzed together using a two-block partial least squares analysis to assess the bones as a functional unit for pedal grasping. Highland grauers and mountain gorillas display similar tarsal shapes that facilitate terrestrial locomotion. In contrast, although more closely related to other eastern gorillas, lowland grauers exhibit tarsal shapes more similar to those of western gorillas and biomechanically linked to climbing (i.e., convergence).

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### Household demography and land-use in a rice-farming village in Laos from 1971 to 2013

SHINSUKE TOMITA<sup>1</sup> and DANIEL M. PARKER<sup>2</sup>

<sup>1</sup>Graduate School of Environmental Studies, Nagoya University, <sup>2</sup>Shoklo Malaria Research Unit, Mahidol Oxford Tropical Medicine Research Unit

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The ratio of food consumption to production (C/P ratio) within households in subsistence farming communities varies across the household life cycle, according to the age and sex distribution of household members. The balance between consumption and production is also likely to play a major role in household member survival and wellbeing, making strategies for the mitigation of within-household resource competition (indicated by high C/P ratios) important. In this research we demonstrate mitigation approaches through the use of work time allocation across the lifecycle, intergenerational land transfers and land reclamation in an intensive farming community in Northern Laos (1971 – 2013). We reconstructed demographic events (e.g. birth, death and migration), as well as household and land-use history and looked at the predictive effects of age cohorts, household C/P ratios and the size of inherited land on the likelihood of land reclamation using event history analysis. We found that the likelihood of reclamation is higher in households with high C/P ratios and age cohorts in their 30 to 60 years old. Households with high competition over food appear more likely to obtain new land for farming, most likely as an approach for mitigating within household produce competition. Households with larger land inheritances were unlikely to reclaim new land regardless of C/P ratio, indicating that intergenerational transfers mitigate the effects of household demography on household economy.

### Trabecular Bone Properties in the Border Cave 3 Infant Ilium: Implications for the onset of Independent Gait in Early Modern *Homo sapiens*

KIMBERLEIGH A. TOMMY<sup>1</sup>, BERNHARD ZIPFEL<sup>1</sup>, JOB KIBI<sup>2</sup> and KRISTIAN J. CARLSON<sup>1,3</sup>

<sup>1</sup>Evolutionary Studies Institute, University of the Witwatersrand, <sup>2</sup>Palaeontology Department, National Museums of Kenya, Nairobi, Kenya, <sup>3</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA.

The Border Cave 3 (BC3) infant skeleton has been understudied, despite its importance as a rare example of a fairly complete immature skeleton of early modern *Homo sapiens*. Based on its dental eruption pattern and a modern human standard, BC3 is 4-7 months old. The study aim is to compare pelvic structure of the BC3 infant to an ontogenetic series of recent modern human infants. Specifically, trabecular structure in the ilium is quantified to investigate whether the BC3 infant matches an equivalently-aged recent modern human. We test the hypothesis that early modern and recent modern *H. sapiens* infants began independent gait at equivalent ages.

Trabecular properties were collected from high resolution images generated by microCT scans of the BC3 infant and eight recent modern humans

spanning 0 – 36 months. Using Quant3D, bone volume fraction, trabecular number and thickness, and degree of anisotropy (DA) were quantified in nine volumes of interest per ilium. Although the BC3 infant is considered 4-7 months old, its generally high DA resembles that observed in older recent modern humans (6 – 36 months). Similar trabecular thickness and number in the BC3 infant and equivalently-aged recent modern human infants may reflect equivalent age-related bone modeling processes. However, organizational (DA) differences may reflect greater efficacy in bipedal gait in the former (i.e., an earlier onset). These results suggest that the BC3 infant may have been more advanced in independent gait than recent modern human infants of the same age, which may have implications for differences in parental care.

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### Studying yellow fever virus susceptibility in humans using a howler monkey model

NICOLE TOROSIN<sup>1</sup>, KAELE FISCHER<sup>2</sup>, JUNE ROUND<sup>2</sup> and LESLIE A. KNAPP<sup>1</sup>

<sup>1</sup>Anthropology, University of Utah, <sup>2</sup>Pathology, University of Utah School of Medicine

Yellow fever virus (YFV) is considered a re-emerging disease with 200,000 persons affected annually. It remains poorly studied compared to other arthropod-borne and hemorrhagic fever viruses. In Central and South America, humans and howler monkeys live in close proximity and both play host to YFV. Howler monkeys die within a week, while humans have a low fatality rate. Due to deforestation and habitat fragmentation, the virus continuously circulates between the howler monkeys and humans. To better comprehend the human pathogenesis of YFV, a multilayered, underutilized comparative approach using humans and non-human primates (NHPs) sharing an environment and pathogenic pressure is underway. Data has been collected in both Veracruz, Mexico from humans and *Alouatta palliata mexicana*, and Misiones, Argentina from humans and *Alouatta guariba clamitans*, to test hypotheses on how DNA sequence differences in innate immune gene, Toll-like receptor 7 (TLR7), and microbiome composition in humans and howler monkeys may affect YFV susceptibility. Results show amino acid variance in a critical region of the TLR7 gene in humans and howlers and differences in their microbiome composition. Future research will compare the TLR7 immune pathway to further evaluate potential causes of variable YFV susceptibility. Studying the immune system and microbiome of humans and howlers will advance human YFV pathogenesis research and help stop the spread of YFV in shared habitats.

### Allometry, sexual dimorphism in human ossa coxae, and its relevance for understanding human torso variation

SHEILA NICOLE TORRES<sup>1</sup>, DANIEL GARCÍA-MARTÍNEZ<sup>1,2,3</sup>, JENNIFER EYRE<sup>4,5</sup>, SCOTT A. WILLIAMS<sup>3,4,5</sup>, JOHN HAWKS<sup>3,6</sup>, CAROLINE VANSICKLE<sup>3,6,7</sup> and MARKUS BASTIR<sup>1,3</sup>

<sup>1</sup>Department of Paleobiology, Museo Nacional de Ciencias Naturales, CSIC, <sup>2</sup>Faculty of Science, Universidad Autónoma de Madrid, <sup>3</sup>Evolutionary Studies Institute and Centre for Excellence in Palaeosciences, University of the Witwatersrand, <sup>4</sup>Department of Anthropology, New York University, <sup>5</sup>New York Consortium in Evolutionary Primatology, New York Consortium in Evolutionary Primatology, <sup>6</sup>Department of Anthropology, University of Wisconsin-Madison, <sup>7</sup>Department of Anthropology, Bryn Mawr College

The thorax and pelvis are integrated systems, important for understanding human body shape and evolution. Research has shown that in the lower thorax, sexual dimorphism and allometry produce wider ribcages in larger males and narrower ones in smaller females. If the pelvis and thorax are integrated, we would expect that the upper pelvis would similarly be wider in larger males and narrower in smaller females. Within this framework of torso integration, we explore allometry and sexual dimorphism in ossa coxae. From a human sample with variation in body size (25 males, 25 females, Bass Collection; N=3 small-bodied humans, AMNH), we measured 142 (semi)landmarks on coxal bones and analyzed them using Geometric morphometrics. These results explore how sexual dimorphism and allometry affect torso width measured from pelvis morphology compared to previous studies of the ribcage. Males and females differ both allometrically and non-allometrically. Allometrically, smaller individuals have wider ossa coxae than larger individuals, regardless of sex; non-allometrically, females have a wider pelvic inlet than males, presumably due to obstetric adaptations. Both findings contradict previous results on lower ribcage dimensions. Our results show that while allometry and sexual dimorphism are important factors explaining ossa coxae morphology, they affect the pelvis and thorax differently, challenging the torso integration model. Morphological and positional relations between both hip bones and the sacrum could account for this. However, interactions between 3D-pelvis shape and size and stature are likely important in the context of pelvis reconstructions and body shape in small-bodied humans and hominins.

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### Moving across the desert: Investigating the remains of travelers who died traversing the Chilean Atacama

CHRISTINA TORRES-ROUFF<sup>1,2</sup>, WILLIAM J. PESTLE<sup>3</sup>, GONZALO PIMENTEL<sup>2</sup> and KELLY J. KNUDSON<sup>4</sup>

<sup>1</sup>Anthropology, University of California, Merced, <sup>2</sup>IAA, Universidad Católica del Norte, Chile, <sup>3</sup>Anthropology, University of Miami, <sup>4</sup>SHESC, Arizona State University

While the pastoralist peoples of the Andes are not typically characterized as nomads, their life included extremely regular and long-distance travel. In northern Chile, there is detailed information about prehistoric trade routes that allows us to visualize large scale networks of connections and illuminate the movement of goods and information. However, much like nomadic peoples, we only have a limited understanding of the people involved in the movement of goods and ideas across these expansive desert spaces. Here, we present an unusual opportunity to explore these questions and the human dimensions of a mobile lifestyle through analysis of the remains of nine individuals excavated on routes that connected the coast with the interior oasis of Quillagua.

We employ both traditional osteological and biogeochemical analyses to investigate the life of these travelers. We documented infants, children, men and women, suggesting that families were mobile and actively participated in the sharing of resources. Moreover, biogeochemical analyses revealed evidence of both coastal and inland populations using these prehistoric routes. Results from carbon and nitrogen isotopes suggest the high consumption of marine resources in some individuals, while others are more aligned with a diet of terrestrial resources. The analysis of radiogenic strontium isotopes supports this, indicating several possible geographical origins for these individuals. Together, these data suggest the possibility of frequent movement along these routes and demonstrate the social relationships between groups despite significant spatial segregation.

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### Ancient hybridization between *Papio* and *Theropithecus* detected at a non-coding region of the X-chromosome

ANTHONY J. TOSI<sup>1</sup>, CHRISTINA M. BERGEY<sup>2</sup> and ANDREW S. BURRELL<sup>3</sup>

<sup>1</sup>Department of Anthropology, Kent State University, <sup>2</sup>Department of Anthropology, Penn State University, <sup>3</sup>Department of Anthropology, New York University

We examined an 11 kb non-coding region of the papionin X-chromosome located within the P2RY10 gene. Contrary to the majority of molecular datasets, phylogenetic analyses of this region recover robust support for a grouping of the genera *Papio* and *Theropithecus* to the exclusion of *Lophocebus*. This pattern is likely the result of

ancestral hybridization, rather than differential lineage sorting, and divergence calculations date the introgression to ~2.6 MYA. Strong selection on the X-chromosome argues against drift as the mechanism underlying the introgression, however it is unclear which gene in the vicinity of P2RY10 was the main target of selection. Yet, the vast majority of synapomorphies clustering *Papio* and *Theropithecus* occur within the last 3 kb of the surveyed region, suggesting that (1) a recombination event occurred following introgression, and (2) the main target of selection is likely to be a coding segment downstream of P2RY10 exon 1.

Funding was provided by the College of Arts and Sciences at Kent State University.

### An Analysis of Gender Constructs in an Early Bronze Age Population Through Principal Coordinates Analysis of Scored Enteseal Changes

MARK TOUSSAINT<sup>1</sup> and PIOTR WŁODARCZAK<sup>2</sup>

<sup>1</sup>Anthropology, University of Nevada Las Vegas, <sup>2</sup>Archaeology, Institute of Archaeology and Ethnology of the Polish Academy of Sciences

Social constructs such as gender are embodied as differential health outcomes, as well as different stresses and demands placed on the musculoskeletal system. This study engages with gender through an analysis of enteseal changes in individuals from two Early Bronze Age cemeteries of the Mierzanowice Culture in southeastern Poland. Mierzanowice burials are particularly suited to analyses of gender, as they are oriented based on sex, with some intriguing exceptions.

Rather than make *a priori* assumptions about the types of activities different gender groups may have been engaged in, this study uses Principal Coordinates Analysis (PCoA) to let any systematic variation in enteseal changes speak for itself. Several entheses (12 left, 12 right) of the upper and lower body from a sample of 27 individuals were scored using the methods of Mariotti *et al.* (2007). A subset of 16 individuals preserved 5 of the same enteseal markers. This data was converted into a distance matrix (Manhattan distance) and PCoA was performed. Each individual was color coded by sex first and then by burial treatment.

When the transformed data are plotted against PC1 and PC2, there appears to be incipient, though poorly defined, clustering by sex. Because this could be an artifact of overall size differences in entheses as opposed to variation in enteseal changes by muscle group, the data were then plotted against PC2 and PC3. In this case, much—but not all—of the clustering disappears.

### Dental pathology, wear, and developmental defects in South African hominins

IAN TOWLE, JOEL D. IRISH and ISABELLE DE GROOTE

Natural Sciences and Psychology, Liverpool John Moores University

Developmental defects, wear, and pathologies can give insight into the diet, behavior, and environmental stresses of past populations. There have been a number of key studies looking at particular defects and types of wear but as yet no broad scale study looking at multiple types across these species. We focus on frequencies of dental caries, chipping, hypoplasia, and occlusal attrition. All South African available hominin material was studied, with the largest samples represented by *Australopithecus africanus* (n= 358 teeth), *Paranthropus robustus* (n= 278 teeth), and *Homo naledi* (n= 142 teeth). Teeth were recorded macroscopically, with a 10x hand lens used to confirm defects. The most striking results are high rates of crown chipping in *H. naledi*, with over 40% of teeth having one or more chip. Occlusal wear as well as comparisons with Cercopithecinae specimens suggest grit being incorporated into their diet may be the cause. The high frequency of pitting enamel hypoplasia in *P. robustus* (permanent teeth= 14%; deciduous molars= 47%) may be explained by morphological differences or a common stress occurring at a key stage in development. Caries frequency in *P. robustus* is 1.8% (5/278) and 2.1% in *H. naledi* (3/142); there are no cases in *A. africanus* (0/358). Dietary differences likely explains this difference, but environmental and bacterial factors are also considered. These examples reveal among-species differences and along with occlusal wear we compare these with later hominins and extant primates to highlight potential dietary and behavioral variation.

### It ain't necessarily "so": James W. Wood, just so stories and the triumph of the proximate determinants approach in human reproductive ecology

DAVID P. TRACER

Health & Behavioral Sciences, University of Colorado Denver

In the Gershwin song, It Ain't Necessarily So, the title character expresses doubt about the veracity of fantastic biblical events presented without tangible evidence. In his course "Human Reproductive Ecology," first offered at the University of Michigan in 1985 and reiterated in his publications, Jim Wood taught students to be skeptical of explanations that appeal to ultimate causes without examining intervening proximate determinants and their measurable effects on outcomes of interest. Demographic and health data (n=550) collected from a small-scale society in Papua New Guinea are presented to show how

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application of Wood's proximate determinants approach to human natural fertility yields results that are different from what is intuitively expected by appealing to ultimate causes alone. Just prior to data collection, the society experienced the introduction of wage-earning opportunities for a small fraction of the population resulting in the betterment of living conditions and health for the wage-earners. While these factors might be expected to lead to higher total fertility rates (TFR) among them, in fact, the TFRs of the wage-earners and those practicing more traditional subsistence are nearly indistinguishable at 6.0 for both groups. An examination of the proximate determinants of fertility demonstrates that while the duration of lactational amenorrhea is significantly shorter among the wage-earning group, higher infant mortality among the traditional group results in truncation of the breastfeeding interval more often and higher "replacement" fertility, thus raising their TFR. This example demonstrates the necessity of considering proximate and not simply ultimate causes when explaining biological outcomes.

### Oral processing profiles of three sympatric colobines in Taï National Park, Côte d'Ivoire

JORDAN N. TRAFFI<sup>1</sup>, M. ALEXANDRA WILLIAMS<sup>2</sup>, ERIN E. KANE<sup>2</sup>, DAVID J. DAEGLING<sup>1</sup> and W. SCOTT MCGRAW<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Florida,  
<sup>2</sup>Department of Anthropology, The Ohio State University

Taï National Park in Côte d'Ivoire contains representatives of all three genera of African colobines: olive colobus (*Procolobus verus*), red colobus (*Piliocolobus badius*), and black and white colobus (*Colobus polykomos*). Though all three colobines are folivorous, dietary divergence in these sympatric taxa is apparent. Olive colobus primarily consume young leaves; red colobus consume young leaves, ripe fruit, and flowers; and black and white colobus consume more mature leaves in addition to unripe fruit and seeds. Here, we characterize the dietary strategy of olive colobines, and investigate whether these divergent dietary strategies require different oral processing strategies. We compare the oral processing behaviors of *P. verus* when consuming different food items, and to sympatric *P. badius* and *C. polykomos*.

Data on *P. verus* oral processing (N=125 scans) were collected from May-August 2016. Though there were no significant differences in mastications per action (Kruskal-Wallis,  $p=0.562$ ) when consuming flowers (15.84), young leaves (18.81), mature leaves (20.74), leaf petioles (20.95), unripe fruit (19.97), and invertebrates (28.50), those foods which compose the majority of olive colobus diets (e.g., young leaves) require less oral processing. On average, *P. verus* engage in fewer

mastications per action (14.96) than sympatric *P. badius* (17.49) or *C. polykomos* (20.40).

We hypothesize that *P. verus* exhibits an oral processing profiles more similar to *P. badius* than *C. polykomos* because relative to the other species, *C. polykomos* relies heavily on mechanically challenging seeds and mature leaves. The specialization of *P. verus* on easy-to-process leaves minimizes their chewing effort relative to sympatric colobines.

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### Anthropological and bioarchaeological approaches to two medieval populations from Reigoldswil (Switzerland)

VIERA TRANCİK PETITPIERRE<sup>1,2</sup>, ALBERT HAFNER<sup>2</sup> and SANDRA LÖSCH<sup>1</sup>

<sup>1</sup>Department of Physical Anthropology, Institute of Forensic Medicine, University of Bern, Switzerland,

<sup>2</sup>Department of Prehistory, Institute of Archeological Science, University of Bern, Switzerland

Human remains of two neighboring medieval cemeteries in Reigoldswil (Bergli and Kirchli) in Northwestern Switzerland were morphologically and biochemically studied. The aim of the study was to analyze differences in social structure, living conditions, subsistence strategies and migration of these two populations, as changes in dominion are assumed.

A total of 156 graves and a MNI (minimal number of individuals) of 294 individuals were analyzed. The skeletons are radiocarbon dated from the 7<sup>th</sup> to the 13<sup>th</sup> century.

The age at death and sex was estimated with established methods and body height was calculated from long bone measurements. Stable isotope ratios of carbon, nitrogen and sulfur were evaluated for 167 individuals.

The age at death distribution shows a high amount of infants at Kilchli compared to Bergli by reason to specific burial practice. In total, more male individuals than females are present in both cemeteries. The calculated body heights show taller individuals at Kilchli, which is significant comparing the females ( $p = 0.042^*$ ). The study of the stable isotopes indicates a mainly terrestrial based diet with no evidence of significant fish consumption. The subsistence was based on C<sub>3</sub> plants, such as barley, wheat and vegetables, but with a probably higher intake of C<sub>4</sub> plants by the males of Kilchli. The stable sulphur values indicate minor mobility of the Kilchli females. All the given evidences point to a difference between the populations and indicate social distinctions of the individuals.

This project was founded by the Marie Heim-Vögtlin Stiftung (PMCDP1\_151471/1)

### Early Colonial Period Exodus to the Southern Maya-Spanish Frontier: Investigating Immigration to Tipu through the use of Strontium and Oxygen Isotopes

WILLA R. TRASK

Central Identification Laboratory, Defense POW/MIA Accounting Agency, Department of Anthropology, Texas A&M University

This project identifies the geographic origin of a subset of 588 Maya buried at Tipu, an early Colonial Period *visita* mission cemetery. Situated at a geographic and cultural frontier, Tipu experienced a dynamic history of fluctuating political alliances and was instrumental in early Colonial frontier politics and trade. Ethnohistoric records indicate that this remote community functioned as a refuge for a large southern exodus of indigenous Maya escaping oppression, forced labor, and other hardships encountered in northern Yucatan regions more firmly under Spanish control.

Radiogenic strontium and stable oxygen isotopes are employed to estimate the birth place of nearly 200 individuals buried at Tipu. Strontium (<sup>87</sup>Sr/<sup>86</sup>Sr) and Oxygen ( $\delta^{18}\text{O}$ ) values from nineteen Postclassic individuals are utilized to understand regional population movements immediately prior to the arrival of the Spanish. A statistically significant difference in the distributions of <sup>87</sup>Sr/<sup>86</sup>Sr and  $\delta^{18}\text{O}$  values is found between the Postclassic and Colonial time periods, confirming the significant, and swift impact of the Spanish on regional migration patterns, even in regions far from the center of Spanish activity. The early Colonial population was largely comprised of migrants, with over half of the sample falling outside the "local" <sup>87</sup>Sr/<sup>86</sup>Sr and  $\delta^{18}\text{O}$  range. The presence of migrants originating from the Itza Maya held Petén, the Maya Mountains, and further north in the Yucatan peninsula, confirm Tipu's importance as a frontier community. These results build upon the ethnohistoric record by suggesting the early Colonial period was characterized by mass population movements from multiple areas within the region.

### The limb proportions of *Homo naledi*

SARAH TRAYNOR<sup>1</sup> and JOHN HAWKS<sup>1,2</sup>

<sup>1</sup>Anthropology, University of Wisconsin-Madison,  
<sup>2</sup>Evolutionary Studies Institute, University of the Witwatersrand

Hominin limb proportions may be influenced by climate adaptation, locomotion, nutrition and phylogeny. Fossil material rarely presents evidence of relative limb lengths of individuals; and more commonly preserves portions of joints or bone cross-sections sampled from multiple individuals. Examination of limb proportions in fossil samples can be accomplished by employing statistical approaches designed for such fragmentary samples. One important

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issue regarding limb proportions in the hominin fossil record is the apparent dichotomy between *Australopithecus*, with relatively large upper limbs and smaller lower limbs, and *Homo erectus* with more humanlike proportions, which may reflect a greater commitment to terrestrial bipedalism, a reduction in arboreal repertoire, and a more humanlike thermoregulatory strategy. But this dichotomy of limb proportions between *Australopithecus* and *Homo* is challenged by the putative *H. habilis* partial skeleton OH 62, which may have more primitive limb proportions, and more recently the *Au. afarensis* partial skeleton, KSD-VP 1/1, argued to be *Homo*-like. *Homo naledi* allows us to address the locomotor and thermoregulatory strategies that were present in the common ancestors of this species and *H. erectus*. I examined the sizes of the relative joint surfaces, midshaft circumference, and total length of the upper and lower limbs bones of *H. naledi* and additional comparative material including the Krapina Neandertal individuals and a large sample of modern humans. By including additional dimensions and data to these approaches, this study adds confidence to the observation that *H. naledi* is similar to *H. erectus* and modern humans in most aspects of limb proportions.

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### An Examination of Sex Differences in Pathological Conditions of the Spine in a Historic Population from Milwaukee, Wisconsin

LORI A. TREMBLAY CRITCHER

Department of Anthropology, The Ohio State University

This aim of this study was to investigate differences in the presence and prevalence of pathological conditions of the spine between males and females in a late 19<sup>th</sup>-early 20<sup>th</sup> century population from Milwaukee County, Wisconsin. The Milwaukee County Institution Grounds Poor Farm Cemetery, a burial ground for the indigent and homeless of Milwaukee County, Wisconsin was excavated in 1991-1992. A subsample ( $n=115$ ) of the adult burials recovered was used for this study. Evidence of the presence of Schmorl's nodes, osteoarthritis, and DISH (diffuse idiopathic skeletal hyperostosis) on the vertebral column was obtained via anthroposcopic analysis. Statistical analyses indicate that while the overall presence of Schmorl's nodes ( $p=.057$ ), osteoarthritis ( $p=.472$ ), and DISH ( $p=.336$ ) was similar for both sexes, there is a statistically significant difference in the prevalence of Schmorl's nodes that occurred on the thoracic vertebrae ( $p=.032$ ), with a higher prevalence among males (39.5%) than females (24%). This suggests that while both impoverished males and females were equally at risk to suffer from these pathological

conditions of the spine, the types of labor or behaviors that impoverished males engaged in in the late 19<sup>th</sup>-early 20<sup>th</sup> century put them at higher risk for thoracic Schmorl's nodes.

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### Puzzling Pairs from Pavlov: Mortuary Manipulation in the Mid Upper Paleolithic

ERIK TRINKAUS<sup>1</sup>, PIOTR WOJTAL<sup>2</sup>, JAROSLAW WILCZYNSKI<sup>2</sup>, SANDRA SAZELOVA<sup>3,4</sup> and JIRI A. SVOBODA<sup>3,4</sup>

<sup>1</sup>Anthropology, Washington University, <sup>2</sup>Institut Systematyki i Ewolucji Zwierząt, Polska Akademia Nauk, <sup>3</sup>Ústav antropologie, Masarykova univerzita, <sup>4</sup>Archeologický ústav, AV ČR, Brno

The archeologically rich earlier Mid Upper Paleolithic (MUP) sites of Dolní Věstonice and Pavlov, southern Moravia, have yielded three single burials and a triple one, and long series of isolated human remains. In addition, the southeastern part of the Pavlov I site has provided a pair of isolated partial hand skeletons, Pavlov 31, and recent zooarcheological analysis of the central portion of Pavlov I has provided two pairs of isolated partial pedal skeletons (Pavlov 37 and 38) plus a pair of probably associated patellae (Pavlov 34 and 35). The only other human bone from Pavlov I central is a partial metacarpal 2 (Pavlov 36). Pavlov 34/35 and 37 represent among the largest MUP individuals known, whereas Pavlov 36 and 38 are average in size; hence these bones could represent two individuals. No other human remains are known from Pavlov I central. The Pavlov 34 to 38 (plus Pavlov 31) human remains are porous and eroded, in contrast to excellent faunal osseous preservation, implying burial in articulation with soft tissue. None of them shows carnivore or cutmark damage. These combinations of isolated pairs of patellar, pedal (and palmar) human remains from Pavlov suggest a pattern of the deliberate manipulation and differential disposal of corporeal portions in the MUP. Manipulation of human bodies, other than full-body burial, has been suggested for the MUP sites of Dolní Věstonice II, Paglicci, Pataud and Sunghir. The puzzling pairs from Pavlov further elaborate these complex MUP mortuary behaviors.

### The Effect of Lifestyle Factors such as Smoking, Activity Level, and Pregnancy on Age Estimation from the Pubic Symphysis: A Study of 1,238 Living Volunteers

JANAMARIE TRUESDELL

School of Anthropology and Museum Ethnography, University of Oxford

Due to the skeletal emphasis of both physical and forensic anthropology, biological profiling has

traditionally been advanced through the study of archaeological, donated, and autopsied remains. In recent years, this has grown to include samples obtained through medical imaging, specifically that of computed tomography (CT), though these investigations have remained largely retrospective. While these types of studies are in keeping with past precedent, this preference for anonymous skeletal material underutilizes the other half of the human equation – the living owners of those skeletons and the ways in which they live their lives.

This study sought to explore the potential benefit of incorporating public engagement into the process of biological profiling research. Over the course of six months, 1,238 volunteers (653 male, 585 female) were interviewed, face-to-face, before being CT scanned at Oxford University's Churchill Hospital. These interviews were facilitated by a six-page questionnaire detailing demographic (biological affinity, age, height, weight, etc.), lifestyle (diet, activity level, inflammation, infection, osteoporosis, arthritis, smoking by ounces or cigarettes per day, alcohol consumption by units per week, etc.), and pregnancy history (age at first birth, epidural, SPD, caesarean, birth weight, length of labour, etc.). The answers to these questions, along with the results of a Suchey-Brooks symphyseal analysis, were then compared to actual age. Sex ( $p=0.008$ , effect size=1.86), smoking ( $p=0.010$ , effect size=1.85), activity level ( $p=0.033$ , effect size=0.69), and menopause ( $p<0.001$ , effect size=7.69) were all significant. Parity was not significant (number of pregnancies,  $p=0.846$ ; number of births,  $p=0.895$ ), nor were any pregnancy related factors.

### Associations between biomarkers of immune function and cognitive performance in forager-horticulturalists with high parasite and pathogen loads

BENJAMIN C. TRUMBLE<sup>1</sup>, JONATHAN STIEGLITZ<sup>2</sup>, AARON D. BLACKWELL<sup>4</sup>, BRET BEHEIM<sup>3</sup>, DANIEL K. CUMMINGS<sup>5</sup>, HILLARD KAPLAN<sup>6</sup> and MICHAEL GURVEN<sup>4</sup>

<sup>1</sup>School of Human Evolution and Social Change, Arizona State University, <sup>2</sup>Anthropology, Institute for Advanced Study in Toulouse, <sup>3</sup>Evolutionary Anthropology, Max Planck Society for Evolutionary Anthropology, <sup>4</sup>Anthropology, University of California Santa Barbara, <sup>5</sup>Anthropology, University of New Mexico

Development and maintenance of human neural capital, including cognitive skills, requires investments of time and energy. Given limited resource budgets, investment in developing and maintaining cognitive abilities trade-off against investments in immune defenses against pathogenic assault. High pathogen burdens are thought to negatively impact cognitive performance, though most evidence comes from studies of community-level deworming interventions,

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or proxy measures of cognitive performance (grade point average, school attendance). Here we assess associations between biomarkers of immune function (i.e. white blood cell subtypes, erythrocyte sedimentation rate) and distinct cognitive domains (i.e. word recall, digit forward, category fluency, visual scan) in a population facing high pathogen loads. Tsimane forager horticulturalists (n=631) aged 18-94 years participated in a cognitive battery and matched blood draw. Hemoglobin mg/dL (Std  $\beta$ = 0.09, p=0.05) and eosinophil count cells/uL (Std  $\beta$ = -0.14, p=0.001) were associated with composite fluid cognitive performance (recall and digit forward tasks) controlling for age, sex, education and Spanish language ability. No biomarkers were associated with crystallized measures of cognition, even in cases of anemia and eosinophilia. This suggests that not all aspects of cognitive performance are equally susceptible to pathogenic burdens; problem solving and executive function (fluid cognition), may be more susceptible to variation in pathogen load than the ability to recall past knowledge and experience (crystallized cognition). The human ecological niche relies on cognitive abilities to extract difficult-to-acquire, high-quality resources via individual learning and social transmission of knowledge. Understanding how pathogen exposure influences cognitive function is important for understanding both cognitive development and decline.

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### Infantile Cortical Hyperostosis or Disseminated Hematogenous Osteomyelitis? The Case of a High Status Child from Huanchaco, Peru

KHRYSTYNE E. TSCHINKEL<sup>1</sup>, GABRIEL PRIETO<sup>2</sup> and JOHN VERANO<sup>1</sup>

<sup>1</sup>Anthropology, Tulane University, <sup>2</sup>Programa Arqueológico Huanchaco, Universidad Nacional de Trujillo Programa INNOVATE PERU

Excavations conducted by Gabriel Prieto on a hillside above the town of Huanchaco (Trujillo, La Libertad) encountered a cemetery with graves dating from c. 200 BC to the early colonial period. One early colonial period (1532-1600 AD) burial contained the remains of a child of about 1.5 years of age. The child is believed to be from a high status family based on the quality of grave offerings. The individual presents with periosteal thickening of various bones, lesions, cortical swelling, and large perforations on the long bones. These features are similar to those described for infantile cortical hyperostosis (ICH, Ortner 2003) and for disseminated hematogenous osteomyelitis (Couper et al. 2001). The child could be afflicted with either disease, although ICH appears more likely. The etiology of ICH is unknown and the disease usually occurs

around birth. Caffey (1978) states that ICH is rarely reported after five months, although Lewis and Gowland (2009) describe a case of ICH in a 1.5 year old. If IG-124 had ICH the child probably experienced painful reoccurring and visible lesions, swelling, fevers, and irritability. In some cases, the pain is severe enough to cause pseudo paralysis, and if the nerves are involved true localized palsies. When the mandible is affected, clinical reports note that children may refuse to eat, leading to death. In IG-124 the mandible is not involved. This, and possible palliative care, may have been factors that allowed the child to survive for a longer period of time.

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### Validity of Post-Mortem Age Estimation Using the Tooth Cementum Annulations in Northeastern Thai Adults

PANYA TUAMSUK<sup>1</sup>, PIMPONG SUWANATHADA<sup>2</sup>, PATIMAPORN PUNGCHANCHAIKUL<sup>3</sup>, NONGNUCH KANHARAT<sup>4</sup> and NAWAPORN TECHATAWEEWAN<sup>1</sup>

<sup>1</sup>Anatomy, Khon Kaen University, <sup>2</sup>Radiology, Khon Kaen University, <sup>3</sup>Pediatric Dentistry, Khon Kaen University, <sup>4</sup>College of Medicine and Public Health, Ubon Ratchathani University

**Introduction:** Age estimation from dental remains is always challenged to many forensic anthropologists. The number of microscopic incremental lines of tooth cementum was potentially associated with adult age. It has been studied in several populations for serving of personal identification in each region.

**Objective:** To validate the correlation between the age from the number of incremental lines of tooth cementum and chronological age in Thai adults.

**Materials & Methods:** The single-root teeth were obtained from 53 patients with known age (25 males; average of age is 57.3±13.5 years and 28 females; average of age is 49.9±12.2 years.). Each tooth was cut as cross-section at the apical third and middle third junction of root and was ground as approximately 80 mm-thickness. All sections were scanned as digital photographs and examined for incremental lines by ImageJ software. Estimation of each age was performed by the combination of the number of incremental lines and the eruption age of each tooth. The correlation was analyzed by Pearson's correlation coefficient.

**Results:** The overall calculated age from incremental lines correlated positively with chronological age ( $R^2=0.94$ ,  $p<0.05$ ), but not different in male and female. However, ten cases (18%) were found age-overestimation about more than 5 years.

**Conclusion:** This study suggested that the post-mortem age estimation by incremental line

calculation in tooth cementum annulations (TCA) of dental remains may use for age estimation in Thais.

**Keywords:** Age estimation/ Tooth cementum annulations/ incremental line/ personal identification/ dental remains/

The Graduate School, Khon Kaen University, Thailand.

### Quantifying muscular response to habitual activity: Toward understanding muscle-bone interactions for anthropological behavioral reconstructions

CASSANDRA M. TURCOTTE<sup>1</sup>, KARYNE N. RABEY<sup>2</sup>, DAVID J. GREEN<sup>2</sup> and SHANNON C. MCFARLIN<sup>1</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, George Washington University,

<sup>2</sup>Department of Anatomy, Midwestern University

Muscle attachment size and/or surface rugosity are frequently used in anthropology as a proxy for living muscle use, and thus as a means to infer activity patterns. However, prior research has shown conflicting results, suggesting that muscle architecture may not always relate as expected to activity levels, complicating efforts to reconstruct behavior from attachment sites. This study uses a sample of control group (n=3) and two experimentally exercised group wild-type mice (running, n=5; climbing, n=5) to ascertain how muscle varies with activity. We investigated gross muscle anatomy and histological variables of two muscles with fibrocartilaginous insertions, the biceps brachii and the gastrocnemius. We predicted that experimentally increased activity would be associated with increased mass and force-production capacity (physiological cross-sectional area; PCSA) of these muscles, ostensibly critical to the development of the enthesis. We also determined fiber length, a measure of serial sarcomere length and a proxy for maximum muscle excursion. Following dissection, images of isolated muscles were collected at 10-16x magnification using a stereozoom microscope and imported into ImageJ. Exercised groups were characterized by lower mean fiber length for both muscles, and increased mean PCSA for the gastrocnemius, compared to controls. However, Kruskal-Wallis rank sum tests did not detect significant differences among groups. Ongoing analyses are expanding the sample size to further explore this relationship between activity level, muscle architecture, and underlying bony morphological changes for application to anthropological behavioral reconstruction.

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### Ontogenetic trajectories of talo-crural joint shape among the two species of *Pan*, *Pan troglodytes* and *Pan paniscus*: Life history and behavioral correlates

KEVIN TURLEY, EVAN A. SIMONS, STEPHEN R. FROST and FRANCES J. WHITE

Anthropology, University of Oregon

*Pan troglodytes* (Pt) and *Pan paniscus* (Pp), separated by the physical barrier of the Congo River, have markedly different behavioral (B) and life history (LH) traits. Their impact on post-cranial shape was explored and ontogenetic trajectories of shape compared by dental age.

Eighty-two talo-crural joint specimens were divided by dental age, teeth erupted into occlusion (M1, M2, M3), with 56 Pt (23, 12, 21) and 26 Pp (7, 9, 10), laser scanned and 27 landmarks placed. LH and B data from Tai for Pt and Lomako for Pp were statistically tested, as were shape and ontogenetic trajectories, with profiles documented.

Singular warp analysis revealed progression from a flexible to a stable profile while Pp shape profile reversed to flexible at M2. Trajectory analysis of the talus showed S.D. ( $p < 0.05$ ) in vector angle and shape with Pp reversing in M2-3 to a flexible profile. The tibia showed Pt changing to a stable profile at M2-3 while Pp continued to the flexible profile. The talus Pp M1-2 path distance (PD) was S.D. shorter and Pp M2-3 PD was S.D. longer than Pt. LH and B Log linear frequency test was S.D. with Pp more arboreal at each age class than Pt, 98% / 56% subadults, and 99.5% / 49% adults.

LH and B data are consistent with an epigenetic factor altering M2 joint shape. Examination of the M1-2 and M2-3 trajectories suggest a genetic difference in talar development in Pp, with Pt following the hominoid model observed in *Gorilla* and *Homo*.

### Spanish Colonial Impacts on Foodways and Diet in the Zaña Valley of Peru: A Multi-Isotopic Reconstruction

BETHANY L. TURNER<sup>1</sup>, PARKER VANVALKENBURGH<sup>2</sup> and BENJAMIN J. SCHAEFER<sup>1</sup>

<sup>1</sup>Anthropology, Georgia State University,

<sup>2</sup>Anthropology, Brown University

Bioarchaeological research has elucidated the varying impacts of European contact on populations throughout the Americas. In Andean Peru, Spanish Chronicles and archaeological research focus disproportionately on the montane heartland of the Inka Empire. Less is known of the colonial period in coastal regions, which boasted their own history of complex polities and distinct economies. This study utilizes multi-isotopic analysis to reconstruct diet and source-water consumption among remains from the coastal site of Carrizales in the Zaña Valley of Peru.

Carrizales was a fishing village-turned-colonial *reducción* (concentrated settlement); faunal and botanical assemblages at the site significantly differ between pre-contact and early colonial phases, suggesting a major reorientation of diet from marine to terrestrial resources. Carbon, nitrogen, and oxygen isotope values were characterized in the enamel carbonate, bone carbonate, and bone collagen of pre-contact (N=5) and colonial-period (N=21) individuals. Results show moderate variation (~4%) in  $\delta^{18}\text{O}$  values and marked variation in individual  $\delta^{18}\text{O}$  enamel-bone spacing, suggesting variation in water consumption but not necessarily extra-regional immigration. Results also show clear bimodality in  $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$ , and  $\delta^{15}\text{N}$  values between the two phases; in particular, carbonate  $\delta^{18}\text{O}$  values vary more and are lower, while  $\delta^{13}\text{C}$  values are higher, among colonial-period individuals. These results suggest that local populations at Carrizales pursued new, and possibly nutritionally inferior, subsistence strategies to cope with Spanish tributary requirements and *reduccia* policies. This study therefore represents an important contribution to understanding how forced resettlement during the Spanish Colonial period transformed foodways, and likely nutritional status, among the region's indigenous populations.

### Population genomics disentangles taxonomic relationships and identifies ancient hybridization in the genus *Chlorocebus*

HANNES SVARDAL<sup>1,2</sup>, ANNA JASINSKA<sup>3,4</sup>, CHRISTOPHER A. SCHMITT<sup>5</sup>, YU HUANG<sup>6</sup>, GEORGE WEINSTOCK<sup>7</sup>, J. PAUL GROBLER<sup>8</sup>, RICHARD K. WILSON<sup>9</sup>, WESLEY C. WARREN<sup>9</sup>, NELSON B. FREIMER<sup>3</sup>, MAGNUS NORDBERG<sup>1</sup> and TRUDY R. TURNER<sup>10,8</sup>

<sup>1</sup>Gregor Mendel Institute, Austrian Academy of Sciences, Vienna Biocenter, <sup>2</sup>Human Genetics, Wellcome Trust Sanger Institute, <sup>3</sup>Center for Neurobehavioral Genetics, UCLA, <sup>4</sup>Institute of Bioorganic Chemistry, Polish Academy of Sciences, <sup>5</sup>Anthropology, Boston University, <sup>6</sup>Shanghai Institute of Materia Medica, Chinese Academy of Sciences, <sup>7</sup>Microbial Genomics, The Jackson Laboratory for Genomic Medicine, <sup>8</sup>Genetics, University of the Free State, South Africa, <sup>9</sup>McDonnell Genome Institute, Washington University in St. Louis, <sup>10</sup>Anthropology, University of Wisconsin-Milwaukee

*Chlorocebus* is one of the most wide-spread of all primate genera. Vervet monkeys are found throughout sub-Saharan Africa and on at least three Caribbean islands. Vervets have been placed either into a single species with six subspecies or into six species with multiple subspecies. We have investigated the likelihood of these scenarios with a dataset that includes 163 wild-caught animals from 11 countries that represent the various taxonomic forms. Aligning whole genome sequencing data against the recently published vervet monkey reference genome, we discovered a total of 61 million

high quality single nucleotide polymorphisms. We computed a neighbor-joining tree from the pairwise genetic differences to reconstruct phylogenetic relationships and investigated differentiation by calculating the fixation index, *F*<sub>st</sub>, between taxa. Our results indicate that vervet monkeys consist of four well-defined taxonomic units that started to diverge ~800 thousand years ago: *sabaeus*, *aethiops*, *tantalus*, and *pygerythrus*. ABBA-BABA tests and cross-coalescence analysis using MSMC, suggest that separation between the taxa was more complicated than a series of bifurcating species splits: initial separation was followed by a reticulating pattern of divergence and secondary contact, leading to an isolation-by-distance pattern that extends across species. We further suggest that the most wide-spread taxon, previously identified as *Ch. pygerythrus* and *Ch. cynosuroides*, is composed of three subordinate taxa that are characterized by lower genetic divergence and complicated episodes of hybridization and genetic exchange: here called *pygerythrus* (south and south eastern range), *cynosuroides* (central Africa from the Congo basin to Zambia), and *hilgerti* (northeastern range) groups.

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### The Impact of Caloric Restriction on Tissue Isotopic (Nitrogen, Carbon and Oxygen) Values

NOREEN C. TUROSS

Human Evolutionary Biology, Harvard University

Whether stress in the form of caloric insufficiency results in isotopic changes to consumer tissues is a matter of debate in the literature. This study reports the nitrogen, carbon and oxygen stable isotopic values from two animal models of caloric restriction: rhesus macaques and mice. Two tissues (hair and nails) were analyzed from the NIH reared calorically restricted and control rhesus macaques, and the isotopic composition of a number of tissues including liver and brain from NIA calorically restricted and control mice were measured.

No difference was seen in the nitrogen isotopic composition of the calorically restricted animals relative to their controls in any tissue while the statistically significant increase in the nitrogen isotopic composition of brain tissue in both control and calorically restricted animals point to the robustness of the metabolic pathways that control nitrogen isotopic fractionation. Carbon isotopic differences in control vs restricted liver are the result of increased lipid content in the control group. Finally, as was observed in a study of reduced growth in a pig, organic oxygen isotopic composition may be the most sensitive monitor of caloric restriction in animals.

## ABSTRACTS

### Examining the Osteological Paradox: Frailty in Mass Graves versus the General Population at the Greek Colony of Himera

JANELLE TYLER<sup>1</sup>, BRITNEY KYLE<sup>2</sup>, APRIL SMITH<sup>3</sup>, STEFANO VASSALLO<sup>4</sup>, PIER FRANCESCO FABBRIO<sup>5</sup> and LAURIE J. REITSEMA<sup>3</sup>

<sup>1</sup>Department of Anthropology, The Ohio State University, <sup>2</sup>Department of Anthropology, University of Northern Colorado, <sup>3</sup>Department of Anthropology, University of Georgia, <sup>4</sup>Regional Archaeological Superintendence of Palermo, Italy, <sup>5</sup>Department of Cultural Heritage, Università del Salento

Bioarchaeologists frequently use skeletal stress markers as a proxy for frailty during life. However, according to the Osteological Paradox, skeletal stress markers also may be indicative of lower frailty because individuals with skeletal lesions survived stressful conditions. Here, we examine prevalence of physiological stress in two skeletal series from the Greek colony of Himera: one from mass graves who died in the battles of Himera (480 and 409 BCE) and another from the general Himera population (648-409 BCE), who most likely died following a major health event, such as disease or nutritional deprivation. This study compares these two populations to determine if stress, indicated by skeletal lesions, is associated with lower morbidity and mortality (more prevalent among the soldier population) or increased morbidity and mortality (more prevalent among the general population). Four skeletal stress indicators, cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia (LEH), and periostitis, were recorded in 173 individuals from Himera (mass grave n=64; general population n=109). All individuals interred in the mass graves were young or mid-aged adults, therefore we compared this sample to young and mid-aged adults in the general population. No differences were observed in the prevalence of cribra orbitalia and porotic hyperostosis. However, chi-square tests showed significantly greater prevalence of LEH ( $p < 0.001$ ) and periostitis ( $p = 0.01$ ) in the general population than the mass graves, pointing to greater morbidity in the general population. This research supports the hypothesis that stressful experiences during life lead to greater frailty and risk of mortality.

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### Linear enamel hypoplasia incidence in bush-dwelling and village Hadza from Tanzania

PETER S. UNGAR<sup>1</sup>, ALYSSA N. CRITTENDEN<sup>2</sup> and JEROME C. ROSE<sup>1</sup>

<sup>1</sup>Anthropology, University of Arkansas, <sup>2</sup>Anthropology, University of Nevada, Las Vegas

Bioarchaeologists often use linear enamel hypoplasias as a proxy for systemic physiological

stress in prehistoric populations; they form during bouts of malnutrition, undernutrition, or disease around the time of weaning. Increased incidences of LEHs have been observed in many cases, for example, with the shift from foraging to farming and with agricultural intensification. Still, there are few comparative studies published of LEH frequency in living peoples in the process of transitioning from a foraging to a farming economy. Here we present LEH data for the incisors and canines of a sample of the Hadza hunter-gatherers from Tanzania. We compare LEH occurrences for individuals ( $n = 76$  people from five separate camps) that spent their toddler years 1) in the bush consuming wild foods, 2) in the village with a weaning diet dominated by domestic cereals, and 3) dividing their time between the bush and village. Our results indicate that bush-dwelling Hadza toddlers have significantly lower LEH occurrences than villagers or transients. A low LEH frequency for the bush Hadza is consistent with a well-balanced diet that meets nutrient requirements of dental development, whereas higher incidences in the village and transient Hadza suggest interruption of enamel secretion due to malnutrition. Such studies provide valuable context with which to interpret and understand bioarchaeological evidence, and to track effects of sedentization on the biology of modern foragers.

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### Objectively Measured Childhood Physical Activity among Small-scale Populations

SAMUEL S. URLACHER<sup>1,2</sup>, J. JOSH SNODGRASS<sup>3</sup>, KAREN L. KRAMER<sup>4</sup>, MARTINA KONECNA<sup>2,5</sup>, HERMAN PONTZER<sup>1</sup> and LAWRENCE S. SUGIYAMA<sup>3</sup>

<sup>1</sup>Anthropology, Hunter College (CUNY), <sup>2</sup>New Guinea Binatang Research Center, Papua New Guinea, <sup>3</sup>Anthropology, University of Oregon, <sup>4</sup>Anthropology, University of Utah, <sup>5</sup>Zoology, University of South Bohemia

Physical activity (PA) is widely recognized as a costly and highly variable component of human energy expenditure. However, reliable PA data from small-scale populations are scant – particularly for children – restricting global understandings of human phenotypic plasticity, energetics, and health. The present research addresses this shortcoming by investigating objective measures of child PA among subsistence populations on three continents. Cross-sectional data were collected from 175 children (age 5-12 years), including Shuar forager-horticulturalists of Amazonian Ecuador ( $N = 72$ ), Garisakang forager-horticulturalists of lowland Papua New Guinea ( $N = 41$ ), and Maya agriculturalists of southern Mexico ( $N = 62$ ). PA was assessed using a triaxial Actical accelerometer worn continuously at the hip for a period of

seven days. Across the sample, children exhibited mean estimated physical activity energy expenditure (AEE) of 525 kcal/day ( $SD = 144$  kcal/day), resulting in a mean estimated physical activity level (PAL – total energy expenditure expressed as a multiple of basal metabolic rate) of 1.71 ( $SD = 0.13$ ). Population-level analyses further demonstrate that PAL differs significantly between populations (all  $p < 0.05$ ), with the Garisakang possessing the smallest mean estimate (PAL = 1.64) and the Shuar possessing the largest (PAL = 1.75). These findings provide evidence for a substantial energetic demand of PA among children in small-scale populations and highlight heterogeneity in child energy use at both the individual and population levels. Existing relationships between child AEE, PAL, and body size are further explored, with a focus on testing hypotheses derived from life history theory models of resource allocation.

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### Students as Scholars in the Field, Lab, Archive, and Table: Models of Undergraduate Research in Biological Anthropology

BETHANY M. USHER

Students as Scholars, George Mason University, Sociology and Anthropology, George Mason University

Involving undergraduates in authentic research benefits both students and faculty. Studies show that undergraduate research helps students develop academically-oriented peer groups, relationships with faculty, and academic knowledge. These attributes contribute to students being retained in college, graduating, and succeeding in post-graduate education and careers. Faculty benefit by having research assistants who contribute new perspectives and making progress on projects that require significant people-power. In colleges with high teaching expectations, undergraduate research may be the most important aspect of maintaining a research program. For undergraduate students, participating in the research process itself is more important than producing a publication, and many students benefit even if their goal is not to attend graduate school to become anthropologists.

Biological anthropology, with our exciting, multi-faceted projects, is a model discipline for supporting undergraduate research. Although undergraduate research has recently been recognized as a "high-impact" practice, many biological anthropologists have long been using a research apprenticeship model, either in the lab or during fieldwork. Additional models for building an inclusive research environment for undergraduates are presented in this poster, based on George Mason University's

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award-winning *Students as Scholars* initiative: using work-study positions to support research; describing research opportunities in introductory courses; scaffolding authentic research skills and projects into courses, capstones, and honors theses; proposing National Science Foundation Research Experiences for Undergraduates Sites; extending fieldwork into individualized research experiences; and rewarding mentoring in hiring, promotion, and tenure.

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### Pregnancy and the upper volumetric expansion of the barrel-shaped ribcage in *Hylobates* and *Homo*

JEANELLE UY, KAEDAN O'BRIEN and JOHN HAWKS  
Anthropology, University of Wisconsin-Madison

One of the greatest challenges of the later stages of pregnancy is breathing, yet accounts of the evolution of the human trunk have given this factor very little attention. During pregnancy, the gravid uterus expands the abdominal cavity into the thorax, reducing the diaphragm's ability to contract. As a result, pregnant females tend to rely on costal breathing using the upper ribcage. Looking at thorax evolution through the lens of pregnancy may explain why modern humans evolved a barrel-shaped ribcage in contrast to the conical ribcage of living great apes. This study examines (1) the volumetric difference in the upper thorax between hominoids and (2) the aspects of the upper thorax that contribute to volumetric differences. We used linear measurements from ribs 1-3 and vertebral bodies T1-T3 from *Gorilla* ( $n=12$ ), *Homo* ( $n=42$ ), *Hylobates* ( $n=8$ ), *Pan* ( $n=11$ ), and *Pongo* ( $n=10$ ) to estimate respiratory area and respiratory volume. The results show that *Homo* and *Hylobates* have relatively large volumes compared to other apes. In humans, the relatively large volume of the upper ribcage is explained by relatively large heights of the vertebrae. Although great apes and humans differ in rib curvature, this difference does not correspond to a difference in respiratory area. Both gibbons and humans have relatively large neonates compared to other hominoids, so the size of the upper thorax in these species may reflect a convergent evolutionary adaptation for increased costal breathing ability due to diaphragmatic breathing impairment during pregnancy.

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### Searching for pathogens in the earliest known colonial epidemic burial in Mexico, Teposcolula Yucundaa

ÅSHILD J. VÅGENE<sup>1</sup>, MICHAEL G. CAMPANA<sup>2</sup>, NELLY ROBLES GARCÍA<sup>3</sup>, DANIEL HUSON<sup>4</sup>, NOREEN TUROSS<sup>5</sup>, ALEXANDER HERBIG<sup>1</sup>, KIRSTEN I. BOS<sup>1</sup> and JOHANNES KRAUSE<sup>1</sup>

<sup>1</sup>Archaeogenetics, Max Planck Institute for the Science of Human History, <sup>2</sup>Center for Conservation Genomics, Smithsonian Conservation Biology Institute, Washington, DC, USA, <sup>3</sup>The Atzompa Project, National Institute of Anthropology and

History, Mexico, <sup>4</sup>Center for Bioinformatics Tübingen (ZBIT), University of Tübingen, Tübingen, Germany, <sup>5</sup>Human Evolutionary Biology, Harvard University, Cambridge, MA, USA

Few infectious diseases cause idiopathic lesions to form in the skeleton, and historical evidence often lacks precision in implicating specific pathogens in past peoples. Recent advances in the development of metagenomic bioinformatics tools, such as Megan Alignment Tool (MALT), allow us to develop full bacterial profiles for ancient material based on DNA comparisons to whole genomes that are publicly available. In the context of paleopathology, MALT can be utilized as a pathogen screening tool. European colonization of the New World in the 16<sup>th</sup> century is historically well documented to have caused successive disease outbreaks amongst Native American populations leading to massive population declines. The causative agent of several of these past outbreaks remains unknown. Here we apply MALT to shotgun sequenced data from the earliest known post-colonial epidemic cemetery site in Mexico called Pueblo Viejo, Teposcolula Yucundaa. Analysis of this collection could provide an important first step towards understanding disease transfer during the colonial period in Mexico.

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### Dogs go places they are not from and eat weird animals in their homes: Reasons for fewer weird animals

KIM VALENTA<sup>1</sup>, ZACH J. FARRIS<sup>2</sup> and SARAH ZOHDY<sup>3</sup>

<sup>1</sup>Anthropology, McGill University, <sup>2</sup>Biological Sciences, Auburn University, <sup>3</sup>Forestry and Wildlife Sciences, Auburn University

Understanding how carnivores affect primate populations is complex, given the highly elusive nature of carnivores, and the rarity of observing predation events in the wild. Despite this, both native and invasive carnivore species can have profound effects on primate population health, and it is critical to estimate their effects, especially on endangered primate species. Here, we report the results of a long-term study using camera trap data (5 years) to estimate native and invasive carnivore populations, and line transect data (3 years) to estimate lemur species density and diversity in the eastern rainforests of Madagascar. We used co-occurrence modeling to investigate patterns of spatial distribution and determine the effects of native and exotic carnivores on three species of lemur (white-fronted brown lemur *Eulemur albifrons*, woolly lemurs *Avahi laniger*, and mouse lemurs *Microcebus sp.*). Our findings demonstrate that both native carnivores and native lemurs are negatively influenced by fragmentation as demonstrated by their strong decreases in occupancy and species richness. We show that the presence of invasive carnivores, specifically dogs, has a

significant negative effect on both endemic carnivores, and lemur populations. For two species of lemurs (mouse lemur and woolly lemur), we show that both lemur species shows apparent avoidance (SIF = 0.72 ± 0.19 and SIF = 0.95 ± 0.07, respectively). These results point to the potentially critical - and largely unexamined - role invasive predators may play in the conservation of primates, and provide additional evidence of the growing conservation threat dogs pose to biodiversity worldwide.

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### Intra- and inter-population affinities among the Medieval English: a preliminary craniometric study

SATU VALORIANI, JOEL D. IRISH, SILVIA GONZALEZ and MATTEO BORRINI

Research Centre in Evolutionary Anthropology and Palaeoecology, School of Natural Science and Psychology, Liverpool John Moores University

Craniometric characteristics can reflect population history and may be used to reconstruct within- and among-group variation, potential migration routes, and ancestral origins. However, studies involving craniometric data within the British isles are unfortunately infrequent, especially for the Medieval period. This pilot study analyzes a set of craniometric data collected in 91 crania from the English Medieval collections curated at Liverpool John Moores University. The sites were selected according to their close chronological relationship but contrasting cultural background: Poulton (Cheshire) was a rural community, while Linenhall (Cheshire) and Gloucester (Gloucestershire) were from an urban context.

Discriminant function analysis (DFA) was carried out on a set of 21 cranial measurements to understand whether any differences exist among the three English samples. These variables were then reduced to 16 to facilitate comparison with the three European samples in WW Howells' databank: Norse (Medieval Oslo), Berg (Carinthia region, Austria) and Zalavar (Western Hungary, 9<sup>th</sup>-11<sup>th</sup> Century).

The first step of the study demonstrated that there is no significant difference among the three British samples, which is likely due to the proximity of the sites. Results of the comparison between the English and the other European samples yield more compelling results. The English cluster together, as do the Norse and the Berg, while the Zalavar sample is more divergent. These findings reflect both the geographic distances among groups and the internal homogeneity of the English samples.

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### The Interaction of Preservation Bias and Analytical Bias in the Fossil Record

ADAM P. VAN ARSDALE

Anthropology, Wellesley College

The human fossil record is limited in fundamental ways that bias our knowledge of human evolution. Certain fossils and localities preserve specific skeletal elements to a greater or lesser degree. Likewise, the analytical techniques we use also potentially bias our knowledge based on the data demands of the techniques in question. In order to examine the interaction between preservation bias and analytical bias, publication records for a sample of 102 Plio-Pleistocene hominin fossils originally published prior to 1988 are compared to their preservation status. Preservation status is catalogued on the basis of a "preservation index" (PI), and the publication records are identified through the frequency of specific fossil mentions, digitally assessed, in the *Journal of Human Evolution* and the *American Journal of Physical Anthropology* from 1988-2015. The results demonstrate a statistically significant difference in the publication rate of well-preserved and poorly-preserved fossils between the first half (1988-2001) and second half (2002-2015) of the examined period. The most poorly-preserved fossils are essentially falling out of the published record, even as the highly-preserved fossils are appearing at a greater rate. The spread of analytical techniques, such as geometric morphometric approaches, are fundamentally shifting what we consider to be the available fossil record. This shift reflects an implicit privileging of "fossil quality" over "fossil quantity," a tradeoff that may or may not be beneficial, but warrants greater explicit examination within the field.

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### From forest to savannah: exploring the mechanical properties of eastern chimpanzee (*Pan troglodytes schweinfurthii*) foods

ADAM VAN CASTEREN and KORNELIUS KUPCZIK  
Max Planck Weizmann Center for Integrative Archaeology and Anthropology, Max Planck Institute for Evolutionary Anthropology

Chimpanzees live in quite disparate environments yet are often described as ripe fruit specialists and purported to adhere to a rather narrow dietary niche. How this diet varies mechanically is poorly understood and there are little data on how physical properties of food may vary across contrasting biomes. To remedy this we measured the toughness (R) ( $\text{Jm}^{-2}$ ) and elastic modulus (E) (MPa) of food items consumed by chimpanzees in the tropical forest (Ngogo, Uganda) ( $n = 718$  samples) and Savannah woodland (Ugalla, Tanzania) ( $n = 523$  samples) during dry periods. The savannah site possessed a much wider breadth of R and E values in comparison to the

tropical forest data. Whilst differences were seen between comparable broad categories of food from both sites the biggest dichotomy was exhibited between the external tissues of savannah plants when compared to their tropical counterparts, indicating that these food tissues are harder to process orally. Although perceive to have a narrow dietary niche we demonstrate that chimpanzees can encounter hard to process items. Extremely stiff and tough outer coatings are rarely masticated; instead they promote biting as an ingestive action utilizing the anterior teeth. This may place stresses on the cranio-dental complex that are likely greater and distinct to those experienced by the post-canine teeth. These results are discussed with reference to chimpanzee dental morphology and demonstrate a degree of within species dietary plasticity throughout different habitats. Data like these can be used to help guide and validate dietary reconstructions of extinct hominins.

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### Males in uniform: intra-individual pelage color variation is associated with social style in male macaques

ANDREW VAN HORN<sup>1,2</sup>, AMANDA N. SPRIGGS<sup>3</sup>, BENJAMIN C. WILHELM<sup>4</sup>, JASON M. KAMILAR<sup>5</sup> and BRENDA J. BRADLEY<sup>2</sup>

<sup>1</sup>Anthropology Department, Temple University,

<sup>2</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University,

<sup>3</sup>Anthropology Department, State University of New York at Albany, <sup>4</sup>Department of Natural Sciences and Mathematics, SUNY Cobleskill, <sup>5</sup>Anthropology Department, University of Massachusetts, Amherst

Sexual dichromatism—differences in coloration between the sexes—is associated with sexual selection in many animal species. As with many potentially dimorphic traits, male coat color is expected to vary with intrasexual competition, while female color is expected to vary in response to environmental variables. Although macaque species are not obviously dichromatic, pelage color may still be an indicator of male quality, and thus subject to sexual selection. Social behavior in macaques has been classified using social "styles," which reflect the rigidity of dominance hierarchies and the strength of inter-individual competition for resources and mates. In order to determine if there is a relationship between social style and variation in uniformity of pelage color, we compared average intra-individual color variation for males and females of eight macaque species with different social styles. We took high-resolution photographs of the dorsal surface of each specimen. We then counted the number of unique colors—unique combinations of RGB values—in the dorsal torso pelage of each individual. Using phylogenetic ANOVA, we found a significant difference in color counts between social styles in males ( $F = 33.270, p = 0.005$ ), but

not in females ( $F = 9.074, p = 0.061$ ). We further analyzed the relationship between color counts and ecological variables (average annual rainfall, average temperature and latitude) using phylogenetic generalized least squares (PGLS). We found no significant correlation between ecological variables and color counts. Our findings suggest that socio-sexual factors exert adaptive pressure on male pelage color uniformity independent of environmental conditions.

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### How the origin of curiosity may have boosted hominin cultural evolution

CAREL VAN SCHAİK, SOFIA FORSS and LAURA DAMERIUS

Anthropology, University of Zurich

Great apes in nature show cultural variation, but their cultural variants hardly accumulated in complexity over time, whereas those of hominins did. Most work attempting to identify the causes of this difference focuses on factors affecting the transmission of novel variants, including demography, social network features and teaching. The role of innovation, beyond a passive effect of demography, has not received as much attention. Here, we examined the causes of variation in problem-solving ability on 5 different tests (a proxy for innovativeness) among a large sample ( $n > 60$ ) of wild-born orangutans kept in rehabilitation centers. Performance varied considerably. This variation was very well predicted by a single factor summarizing the subjects' responses to novel and familiar objects and their exploration style, and was interpreted as curiosity. The extent of curiosity, in turn, was predicted by the duration of time spent with humans. This result demonstrates that innovativeness can vary markedly at identical brain size. We suggest that the birth of curiosity turned hominin innovations from opportunity-driven, as in other primates, into necessity-driven, strongly boosting cultural evolution, unique to humans. We also try to assess the timing of this switch, and link it to the origin of behavioral modernity in early *Homo sapiens*.

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### Defining Lateral Iliac Flare in Hominins

CAROLINE VANSICKLE

Department of Anthropology, Bryn Mawr College, Department of Anthropology, University of Wisconsin–Madison, Evolutionary Studies Institute, University of the Witwatersrand

The degree of lateral iliac flare in the hominin pelvis has functional implications for trunk breadth and locomotion. Yet the evolutionary importance of this character has been obscured by how broadly the term "lateral iliac flare" is applied to the fossil record; today multiple

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hominin species are described as laterally flared despite having different iliac morphologies. The confusion comes from treating lateral iliac flare as a two-dimensional dichotomous character, where any broadening of the bi-iliac breadth can be mistaken for flare that is either present or absent. The evolutionary, taxonomic, and functional implications of having a laterally flared pelvis are not clear when there is such over-use of the phrase. Here I demonstrate that there are four features that contribute to our perception of flare and that each varies continuously—not dichotomously—in hominins. To account for these observations, I recommend a new definition of lateral iliac flare that treats flare as a three-dimensional continuous trait. This new definition will make it possible for researchers to be more precise about the specific features that differ between hominin pelvic fossils while still identifying a character of functional importance.

### Isotopes of Coastal Ecuador

LAURA VAN VOORHIS<sup>1,3</sup>, JOHN KRIGBAUM<sup>1</sup>, VALENTINA MARTINEZ<sup>2</sup> and NICOLE JASTREMSKI<sup>3</sup>  
<sup>1</sup>Anthropology, University of Florida, <sup>2</sup>Anthropology, Florida Atlantic University, <sup>3</sup>Anthropology, Central Washington University

A preliminary report is presented on research into the diet, health, and mobility patterns for prehistoric coastal Ecuador, based on an analysis of both modern data and archaeological data from Site 035 Salango. An assessment of dietary habits provides insight into a broad range of societal developments, such as the implementation and timing of maize agriculture. Additional insights are provided by an osteological evaluation of human remains, with a particular focus on evidence of pathologies associated with diet. Establishing whether the individuals were born locally, as well as the geographic place of origin for non-native individuals, yields insight into social and economic aspects from the past.

Starting with an isotopic baseline for the coastal region of Ecuador, derived from contemporary water, soil, flora, and fauna samples, together with selected archaeological samples, we can compare the isotopic content of human remains to draw conclusions about the deceased's diet and residences. Preliminary results are presented based on archaeological samples of four individuals and contemporaneous fauna derived from three distinct tomb burials from the Manteno culture. Individual teeth and bone samples from the same individual are utilized to construct a comprehensive life history to provide insights into patterns of diet and migration.

### The Effect of Age on Nasal Aperture Shape in Humans

ALEXIS VARVARES and VALERIE B. DELEON  
Department of Biological Anthropology, University of Florida

Nasal aperture shape is known to be informative for estimating ancestry in humans. Age is predicted to be another important covariate of nasal shape. Here, we apply a morphometric approach using sliding semilandmarks to describe nasal aperture shape relative to the midface and test the effect of age. CT image data from 25 individuals under the age of 17 were obtained from the Bosma Collection and reconstructed in Amira. Landmark coordinate data from 3D surfaces were collected in multiple trials for fixed landmarks (nasion, nasale, anterior nasal spine, basion, right and left masseteric tubercles) and points defining the right and left curves of the nasal aperture. Morphometric analyses included resampling of curves, definition of sliding semilandmarks, and Procrustes superimposition in the Geomorph package of R. An additional step of enforcing object symmetry was performed in MorphoJ. Repeatability analysis indicated that among-individual variation exceeded within-individual measurement error. Principal components analysis was used to summarize shape variation in this sample. Contrary to expectation, age had a significant but very weak correlation with nasal aperture shape as defined by the first principal components. Variation related to ancestry or other factors may play a more important role in determining nasal aperture shape in juvenile crania.

### Overweight and obesity prevalence and tracking after 2 years follow up study in children and adolescents from Havana, Cuba

VANESSA VAZQUEZ, JORGE LUIS GÁLVEZ, MARÍA ELENA DÍAZ and DULCE MILAGROS NIEBLA  
ANTHROPOLOGICAL MUSEUM MONTANE, UNIVERSITY OF HAVANA

The goals of the study are to estimate the prevalence of overweight and obesity in schoolchildren of Havana and tracking both conditions after 2 years. The follow-up study began in 2013 with an anthropometric survey of 306 children aged 9-12 years old from two elementary schools, where 99 were overweight or obese according to body mass index (BMI). On a second survey, in 2015 and 2016, we examined 56 of those 99 students, aged 11-13 years old. We determined weight, height, BMI and waist circumference with Cuban references in both surveys. Distributions of frequencies and cross tables 2 x 2 for discreet variables were performed. The Test of Wilcoxon was used for analyze the changes in classification of overweight and obesity for BMI and risk and atypical values for waist circumference, with

a significance level of  $p < 0.005$ . The data were analyzed with the statistical package SPSS 16.0. Prevalence of overweight and obesity according to BMI was 32.3 % in the first survey. From the 56 originally overweight and obese students, after 2 years, 26 % of girl and 7 % of boys becoming normal weight, however, 25% of schoolchildren remain overweight and 39% obese, without change their classification [Z Wilcoxon = -2.683,  $p=0.007$ ]. The 32 % of schoolchildren continue with risk values for waist circumference and 39 % with atypical, also without change their classification [Z Wilcoxon = -0.215,  $p=0.830$ ]. In the sample the overweight and obesity in childhood continue in adolescence, also related with central adiposity

### Shifts in the distribution of rat body sizes through time at Liang Bua: New paleoecological insights into the extinction of *Homo floresiensis* and other endemic taxa

ELIZABETH GRACE VEATCH<sup>1</sup>, MATTHEW W. TOCHER<sup>1,2,3</sup>, THOMAS SUTIKNA<sup>4,5</sup>, JATMIKO<sup>4,5</sup>, E. WAHYU. SAPTOMO<sup>4,5</sup> and KRISTOFER M. HELGEN<sup>6</sup>

<sup>1</sup>Department of Anthropology, Emory University, <sup>2</sup>Department of Anthropology, Lakehead University, <sup>3</sup>Human Origins Program, NMNH, Smithsonian Institution, <sup>4</sup>Centre for Archaeological Science, University of Wollongong, <sup>5</sup>Department of Archaeology, Pusat Penelitian Arkeologi Nasional, <sup>6</sup>Division of Mammals, NMNH, Smithsonian Institution

Liang Bua, a cave site on the Indonesian island of Flores, is best known as the type locality of the enigmatic hominin species, *Homo floresiensis*. Excavations at Liang Bua have recovered large numbers of vertebrate skeletal remains, including over 230,000 skeletal elements that belong to at least five genera of murine rodents (i.e., rats). These taxa vary considerably in body mass from ~72 g to ~1,500 g. Temporal variations in the abundances of these differently-sized rats at Liang Bua could reflect important shifts in past climate, environment, and/or ecology over the past 190 thousand years (ka). To explore potential temporal variation in rat abundance during this time, we measured rat femora (N=10,212), humeri (N=1,474), and calcanei (N=372) from all currently recognized stratigraphic units at Liang Bua. A comparative sample of extant Southeast Asian murid species was used to estimate five body size classes for the subfossil murines at Liang Bua. Changes in the abundances of these body size classes across successive stratigraphic units were quantified using chord distance, and further explored using cluster and correspondence analyses. Results show a major shift in the distribution of rat body sizes at Liang Bua immediately following a volcanic eruption that occurred ~60 ka, suggesting that environmental change was part of the processes that ultimately led to the extinction of *H. floresiensis* and other endemic taxa ~50 ka ago. These results further underscore the importance of small mammal

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assemblages for interpreting the paleoenvironment and paleoecology of hominin sites.

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## Estimating Age at Death through Cementum Annulations in Canines and 1st Molars: A Late Formative Period (400 B.C. - 150 B.C.) Population from Cerro de la Cruz in the Lower Río Verde Valley of Oaxaca, Mexico

CARLOS VEGA<sup>1</sup>, ARION T. MAYES<sup>1</sup> and ARTHUR A. JOYCE<sup>2</sup>

<sup>1</sup>Anthropology, San Diego State University,  
<sup>2</sup>Anthropology, University of Colorado Boulder

During excavations in 1988 for the Río Verde Formative Project (RVFP) ( $n = 86$ ) individuals representing the Minizundo phase (400 B.C. - 150 B.C.) were excavated at Cerro de la Cruz in the lower Río Verde Valley in Oaxaca, Mexico. Age estimation is an important factor in building a biological profile of an individual and ultimately of a larger group. The incomplete, distorted, and fragmentary skeletal remains have made estimating the age of the individuals difficult. Research indicates that cementum annulations may be used as a reliable way of estimating age. This research tested Dental Cementum Increment Analysis (DCIA) as a way of estimating age on ( $n = 45$ ) teeth from ( $n = 28$ ) individuals. Cross-sections of the middle third of each root were processed to a desired thickness using a Buehler diamond blade saw and a Buehler polisher/grinder. Under 10x magnification on a Primo Star microscope digital images were taken and process using Photoshop Elements 13 to count visible cementum bands. The analysis showed 36/45 (80%) of the teeth with visible cementum bands and 9/45 (20%) of the teeth had the cementum region missing or damage and bands could not be counted. The data indicates a tendency to underestimate the age of individuals using DCIA due to a majority of samples having incomplete cementum regions or obscure regions where cementum bands could not be seen. DCIA can be used reliably on archaeological samples from this region, but accuracy depends greatly on the preservation of samples.

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## Effects of Agricultural Transitions on the Evolution of Human Sensory Systems

CARRIE C. VEILLEUX<sup>1</sup>, EVA C. GARRETT<sup>2,3</sup>, RICHARD J. BANKOFF<sup>4</sup>, NATHANIEL J. DOMINY<sup>5</sup>, GEORGE H. PERRY<sup>4</sup> and AMANDA D. MELIN<sup>2,6</sup>

<sup>1</sup>Anthropology, University of Texas at Austin,  
<sup>2</sup>Anthropology & Archaeology, University of Calgary,

<sup>3</sup>Anthropology, Boston University, <sup>4</sup>Anthropology, The Pennsylvania State University, <sup>5</sup>Anthropology, Dartmouth College, <sup>6</sup>Medical Genetics, University of Calgary

The transition from hunting and gathering to agricultural food production, beginning around 10,000 years ago, created a dramatic shift in how people acquire and process food. These shifts to agriculture resulted in major changes in human environments and biology, including metabolic and immune function. In other primates and non-primate mammals, sensory systems are often tightly linked to foraging strategy, such that dietary changes are associated with changes in the genes involved in taste, olfaction, and color vision. In this study, we investigated how the shift to agriculture influenced the evolution of human sensory genes. We used targeted capture and sequencing to analyze 898 genes (encoding taste receptors, olfactory receptors, and cone photopigments) and 71 neutral intergenic regions in 165 individuals from two distinct geographic regions: Uganda and the Philippines. In each region, we sampled two hunter-gatherer populations and a neighboring agricultural population, thus allowing us to compare sensory genes across two independent transitions to agriculture. We employed allele frequency-based tests ( $F_{ST}$ , population branch statistics, and  $bayenv2$ ) to identify candidate functional variants across sensory genes that may reflect subsistence strategy adaptations and compared sensory gene pseudogenization across subsistence strategies. We find that subsistence strategy influenced subtle shifts of allele frequencies in functional variants in at least two bitter taste receptor genes and thirteen olfactory receptor genes shared by populations from both Uganda and the Philippines, suggesting the transition to agriculture is associated with changes in sensory capabilities.

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## Gender, ethnicity, and diet in the Late Intermediate Period, Colca Valley, Peru: A study of carbon and nitrogen isotope ratios from bone collagen

MATTHEW C. VELASCO<sup>1</sup> and TIFFINY A. TUNG<sup>2</sup>

<sup>1</sup>Department of Anthropology, Cornell University,  
<sup>2</sup>Department of Anthropology, Vanderbilt University

Stable isotope analysis of diet can provide a reliable means of evaluating ethnohistoric models of resource procurement in the Andes. According to Spanish colonial documents, the highland Colca Valley was an important economic node in the Inka Empire. Agriculturalists and pastoralists occupying the lower and upper valley were differentiated by subsistence practices and also by distinct forms of language, dress, and cranial modification. Whether or not these differences

were long-standing, or cultivated by the Inka state, remains unclear. Moreover, it is unknown how economic specialization structured food access and consumption along ethnic and gender lines.

To address these gaps, this study presents stable carbon and nitrogen isotope ratios in bone collagen for 46 individuals from two cemetery sites in the upper Colca Valley. Two key patterns emerge when data are partitioned by time period and into groups based on cranial modification: 1) In the early Late Intermediate Period (A.D. 1150-1300), sex-based differences in  $\delta^{13}C$  and  $\delta^{15}N$  are more pronounced, suggesting that males experienced greater access to carbon and nitrogen-enriched foods, such as maize and camelid meat; 2) In the late Late Intermediate Period (A.D. 1300-1450), dietary differences between the sexes level out, yet modified individuals exhibit statistically lower  $\delta^{15}N$  values compared to unmodified individuals. In particular, females exhibiting circular modification exhibit the lowest nitrogen values and show higher heterogeneity in  $\delta^{13}C$ , relative to other subgroups. These results suggest that diverse resource procurement strategies not only preceded Inka intervention, but were also dynamically shaped by gender and ethnic identity across time.

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## Three-dimensional analysis of facial aging and asymmetry from juvenile to old age

JANA VELEMÍNSKÁ<sup>1</sup>, EVA HOFFMANNOVÁ<sup>1</sup>, JANA KOUDELOVÁ<sup>1</sup> and JÁN DUPEJ<sup>1,2</sup>

<sup>1</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>2</sup>Department of Software and Computer Science, Faculty of Mathematics and Physics, Charles University

Factors such as growth, weight gain or loss, ageing, and facial expression have known associations with changes in facial soft tissues. Facial asymmetry is also not stable during human life. A detailed understanding of facial soft tissue development is important in a variety of scientific disciplines dealing with facial reconstruction, forensic identification, aging prediction, or facial recognition. The main goals of this study were to (1) model facial senescence and (2) evaluate development of facial asymmetry of both sexes from juvenile to old age.

Our study was based on the analysis of three-dimensional facial surface models of 298 individuals 15–80 years of age. Facial surface scans were obtained using a structured light-based optical scanner. The evaluation consisted of automatic correspondence search, PCA, asymmetry analysis and per-vertex t-test. Ageing in both sexes shared common traits, but male faces exhibited more intense ageing changes (longer ageing trajectories, with a change of

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direction after 30 years). Sexual dimorphic traits increased until adulthood but tended to diminish in the elderly age category. Facial asymmetry exhibited a similar distribution in both sexes during ageing (right side was larger, located anterior relative to perfectly symmetric surface, the right eye tended to be placed deeper in the socket). Significant changes in asymmetry during aging were encountered in distinct age groups and areas of the face for both sexes. The greatest magnitude of asymmetry was found in the eldest age group.

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### Sexual Dimorphism in an Early Medieval Population (IX.-XI. Century) from Central Europe and its Relationship to Socio-economic Stratification

PETR VELEMINSKY<sup>1</sup>, PETRA STRÁNSKÁ<sup>2</sup>, JÁN DUPEJ<sup>3,4</sup>, PETRA HAVELKOVÁ<sup>1</sup>, SYLVA KAUPOVÁ<sup>1</sup>, JAN FROLÍK<sup>2</sup>, LUMÍR POLÁČEK<sup>5</sup> and JAROSLAV BRUZEK<sup>3</sup>

<sup>1</sup>Department of Anthropology, National Museum, Prague, <sup>2</sup>Department of the Archaeology of Landscape and Archaeobiology, Institute of Archaeology of Czech Academy of Sciences, Prague, <sup>3</sup>Department of Anthropology and Human Genetics, Faculty of Science, Charles University, <sup>4</sup>Department of Software and Computer Science, Faculty of Mathematics and Physics, Charles University, <sup>5</sup>Research Centre for Slavonic and Medieval Archaeology, Institute of Archaeology of Czech Academy of Sciences, Brno

The subject of our contribution is a study of sexual dimorphism (SD) on the basis of linear measurements of long limb bones in relation to socio-economic conditions. We intend to focus on the early medieval Great Moravian and Bohemian populations. The aims were to ascertain: (1) the degree of SD in both population groups, (2) the differences in the degree of SD between the Great Moravian and Bohemian samples, and (3) to verify the assumption that SD is more pronounced in groups living in optimal living conditions, (4) the chronological differences in the degree of SD on the territory of Bohemia. We evaluated skeletons from (1) The Great Moravian Empire (9.-10<sup>th</sup> century AD; N = 80 males, 78 females) and (2) The Bohemian Principality (9.-11<sup>th</sup> century AD; N = 55 males, 62 females). We focused primarily on the 25 length and width measurements of long limb bones. To verify the differences between both sexes, we used logistic regression and linear discriminant analysis. The results are also equations for estimating sex affiliation. Marked differences in SD were found between the Great Moravian and Bohemian populations. SD was pronounced in the Great Moravian population. Less pronounced differences were found among individuals within the same territory. The population with better living conditions has evidently pronounced SD

as opposed to others. Our conclusion confirms the assumption that sexual dimorphism is one of the indirect indicators of the quality of living conditions.

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### Divisions of Labor at Daily Timescales among Batek Hunter-Gatherers

VIVEK V. VENKATARAMAN<sup>1</sup>, THOMAS S. KRAFT<sup>2</sup> and KIRK M. ENDICOTT<sup>3</sup>

<sup>1</sup>Department of Human Evolutionary Biology, Harvard University, <sup>2</sup>Department of Biological Sciences, Dartmouth College, <sup>3</sup>Department of Anthropology, Dartmouth College

Divisions of labor are a central feature of hunter-gatherer societies. Classical models emphasize sex differences in foraging that result in nutrient complementarity at the level of marital pairs, but the social complexity of divisions of labor in humans is now more widely appreciated. To better understand the social and ecological context of divisions of labor in hunter-gatherers, we analyzed a historical dataset from 1975-1976 on the foraging behavior of nomadic Batek living in the tropical rainforests of Peninsular Malaysia ( $n = 93$  days). Foraging returns were weighed and sharing interactions were recorded every day for every individual in camp during the study period. Using these data in combination with nutritional estimates of foraged foods, we analyzed how labor was divided among individuals, kin groups, and the sexes at a daily timescale. Our results highlight the dynamic and context-specific nature of Batek divisions of labor but also support the utility of nutrient complementarity and risk-sensitivity models in explaining foraging decisions.

### Dental Modification and Human Sacrifice at Midnight Terror Cave

CRISTINA VERDUGO, KIMBERLY ZHU and LARS FEHREN-SCHMITZ

Anthropology, University of California, Santa Cruz

Dental modification in Mesoamerica dates from the Early Preclassic Period and persists into the 16<sup>th</sup> century when it was noted by Diego de Landa. Midnight Terror Cave, Belize is a large ritual site containing more than 10,000 bones of human sacrificial victims. The 101 modified teeth recovered represent the largest collection from a single site. This large sample size provides opportunities to critically examine previous hypotheses. The dental collection contains a total of 194 incisors, of which 85, are modified, or 44% of the total incisors recovered. Twelve different modification types from Romero's (1970) classification system have been identified. Of the measured incisors only 5 (.03%) show significant enamel hypoplasia and dental caries. No modified teeth

display these features. Most often, modification is seen as related to elite status. If correct, the high percentage of modification could indicate that elite individuals were sacrificed far more frequently than previously suspected. Alternatively, it may indicate that dental modification is not related to social class. Bimodal distribution has been identified in the right I1 of the maxilla and the left I1 of the mandible suggesting the presence of both males and females in the sacrificial population. However, bimodal distribution does not appear in the modified teeth. Paleogenetic testing is currently being conducted on samples to determine the sex and haplogroup of the individuals. As aDNA analyses progress it will become possible to better address issues of social status, lineage, and sex.

### Linking manipulative abilities to hand morphology in bonobos

EVIE E. VEREECKE and MARIE VANHOOF

Campus Kulak, University of Leuven

Primate manipulative abilities have been studied intensely, primarily in the context of the evolution of human dexterity, but less attention has been given to primate hand morphology. This makes it difficult to link gripping abilities to specific anatomical features, which also impedes the interpretation of fossil remains. In this study, we focus on bonobos (*Pan paniscus*), who use a variety of grip types for grooming, food collection and tool-use and can be regarded as being dexterous despite their relatively short thumb. Unlike modern humans, bonobos use their hands during manipulation and locomotion leading to conflicting mechanical demands.

We have performed a detailed analysis of the extrinsic and intrinsic hand musculature of five bonobo specimens obtained via collaboration with the Royal Zoological Society Antwerp. Each specimen was carefully dissected, the muscle architecture was quantified and CT-scans were taken of each hand to measure articular areas.

When looking at the physiological cross-sectional area (PCSA), the proportion of hypothenar muscles is similar between bonobos and humans (22% vs. 25% intrinsic hand muscles). The relative PCSA of the thumb muscles was also comparable between bonobos and humans (15% vs. 17% total hand muscles), as was the estimate of basal thumb joint pressure (ca. 4 MPa). This suggests that the basal thumb joint in bonobos is subjected to relatively high loading due to the high force-generating capacity of the thumb muscles. In addition, the observed fusion between different hand muscles points to a functional coupling between movements of the thumb and other fingers.

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### Ecomorphology of the fossil monkey community of the Hadar and Ledi-Geraru sites, Afar Region, Ethiopia

MARIE VERGAMINI<sup>1</sup>, AMY L. RECTOR<sup>2</sup> and KRISTI L. LEWTON<sup>3</sup>

<sup>1</sup>Department of Biology, Virginia Commonwealth University, <sup>2</sup>Anthropology, School of World Studies, Virginia Commonwealth University, <sup>3</sup>Department of Cell & Neurobiology, Keck School of Medicine, University of Southern California

The Hadar and Ledi-Geraru fossil monkeys were recovered mostly as isolated elements. Retrodicting the behaviors of fossil mammals, including primates, is essential to reconstructing the paleoenvironmental parameters within which *Australopithecus afarensis* and early *Homo* evolved in the Afar. Because of the fragmentary nature of the fossils, methods of ecomorphological analysis of locomotor behaviors focusing on long bone joint surfaces were applied.

Monkeys represent the majority of non-hominin primates recovered from many east African localities. To reconstruct habitat use of fossil monkeys, this study applies 3D geometric morphometric analyses to distal humeri and proximal ulnae of >70 extant cercopithecoids with varying locomotor habits to differentiate morphology associated with locomotor behavior and substrate use, particularly focusing on semi-terrestriality. Multivariate analyses quantifying modern variation were then used to retrodict locomotor behaviors of more than 60 isolated fossil monkey elements from Hadar and Ledi-Geraru, using data subsets to account for missing points on fossils.

Results of PCA, DFA, and PGLs suggest that morphology of the distal humerus and proximal ulna can be successfully used to distinguish arboreal, terrestrial, and semiterrestrial substrate use in modern cercopithecoids. Further, the variation in these elements can be used to identify likely substrate use of fossil monkeys. For most localities, the fossil primate communities of Hadar and Ledi-Geraru are reconstructed as significantly terrestrial through time. *A. afarensis* and early *Homo* co-existed and evolved within a community of primates approaching similar body size who also spent a significant part of their time moving, and likely foraging, on the ground.

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### Genetic variation of southern Africa hunter-gatherers and the impact of admixture with farming and pastoralist populations

MÁRIO VICENTE<sup>1</sup>, PETER EBBESEN<sup>2</sup>, MATTIAS JAKOBSSON<sup>1</sup> and CARINA SCHLEBUSCH<sup>1</sup>

<sup>1</sup>Department of Organismal Biology, Evolutionary Biology Centre, Uppsala University, Uppsala, Sweden,

<sup>2</sup>Department of Health Science and Technology, University of Aalborg, Aalborg, Denmark

Southern African autochthonous hunter-gatherers, known as Khoe-San or Khoisan, harbor

the deepest genetic lineages among humans. Khoe-San populations are also known for their click-consonant lexicon, which linguistically clusters into three distinct language families. Throughout history, these groups have been largely isolated until the arrival of pastoralists and farmers in the region, starting approximately 2,000 years ago. The farming societies out-competed Khoe-San groups who, to a large extent, were replaced and/or assimilated by farming groups.

We examined a combined genome-wide polymorphism dataset of previously published southern Africa populations in conjunction with a hunter-gatherer group, collected at the settlement of Khan, in Central Kalahari Game Reserve – Botswana. The Khan individuals were sampled prior the relocation of their settlement during the late 1980s and consequently, contemporary admixture and cultural loss.

In the present study, we assess the genetic diversity among 17 Khoe-San groups to provide further information about the principal genetic affinities among groups and the influence of geography and linguistics on genetic variation. Additionally, we present new evidence of how the arrival of and admixture with pastoralists and farmers has shaped the extant Khoe-San genomes. We furthermore assess how neighboring groups influenced ecological dynamics and consequently, Khoe-San genomic affinities and diversity patterns.

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### First case of cd39 $\beta$ -thalassemia found in a Sardinian man from 2000 years ago

CLAUDIA VIGANÒ, GÜLFIRDE AKGÜL, FRANK RÜHLI and ABIGAIL BOUWMAN

Institute of Evolutionary Medicine, University of Zurich

According to historical records, malaria arrived in Sardinia about 2600 years ago when the Punic invaded the island. Nowadays, the island's history of endemic malaria is testified by high frequencies of haemoglobinopathies observed in the Sardinian population. Of particular interest is the cd39 mutation, which is responsible of more than 95% of all  $\beta$ -thalassemia cases observed in modern Sardinians.

Currently, there are debates about the origin of the mutation, and whether its presence in the western Mediterranean reflect the migration of people away from Sardinia or the settlement of the island by a small founding population, like the Punic, who may have carried the disease allele.

This study reports a case of cd39  $\beta$ -thalassemia found in a Punic/Early Roman burial in Sardinia and its origin. The findings are based on PCR analysis of the aDNA of 19 individuals sampled from three different Punic and Roman necropolises in Sardinia. Results showed that this individual carrying the disease allele was of Sardinian

descent and therefore, was most likely one of the first Sardinians affected by  $\beta$ -thalassemia.

*Mäxi foundation*

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### Harnessing the Power of the Genographic Project Database to Research Migrations in War-Torn Regions: Mitochondrial DNA Diversity in Afghanistan

MIGUEL G. VILAR<sup>1</sup>, GREGORY VILSHANSKY<sup>1</sup>, D. ANDREW MERRIWETHER<sup>2</sup> and MICHEL SHAMOON POUR<sup>2</sup>

<sup>1</sup>Science and Exploration, National Geographic Society, <sup>2</sup>Department of Anthropology, Binghamton University

Molecular Anthropology and Phylogeography can often be constrained by DNA sample accessibility, necessitating researchers to infer migratory routes through regions where sampling is otherwise difficult or dangerous. Further, war-torn regions are modern epicenters of population shifts and forced migrations, as a consequence of war, continuously changing the genetic landscape. In order to show the power of the Genographic Database (DAR) in researching past and current migrations, we analyzed the mitochondrial DNA (mtDNA) patterns in the nation of Afghanistan, also including neighboring countries of Central Asia for comparison. Only Genographic Project participants who had maternal Afghan ancestry were included in the main analysis. The results were then compared to data from other projects in Central Asia—Kazakhstan, Kirgizstan, and Northern India—as well as unpublished data from Pashtun populations from eastern Afghanistan. The DAR yielded 214 participants of Afghan maternal ancestry, accounting for 46 distinct mtDNA haplogroups and including several unique haplotypes. Among those samples more than half were West Eurasian lineages, 12% were South Asian, 10% were East Asian, and 5% were Sub-Saharan African. Neighboring groups to the North (Kazakhs and Kyrgyz) and East (Indians from Jammu and Kashmir) showed some of the same lineages, suggesting recent, yet limited gene flow. Ongoing Y chromosome and autosomal DNA analyses also show high diversity for Afghanistan. This work demonstrates the value of databases in enhancing our understanding of human prehistory.

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### New insights into locomotion and posture in hominoid evolution: integration of the skull and cervical vertebrae

CATALINA I. VILLAMIL

Center for the Study of Human Origins, Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology

The cervical vertebrae play an important role as mediators between the cranium and postcranium, an interaction that is especially interesting in bipedal hominins. However, little is known

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about cervical vertebral evolution. Although the cervical vertebrae are developmentally linked to the cranium, many authors have posited that the cervical column evolves primarily in response to locomotion and posture. If so, we should expect that integration among cervical elements and the cranium will vary between taxa with different locomotor and positional behaviors, more closely reflecting biomechanical selective pressures than developmental ones. To test this hypothesis, I collected linear measurements on the basicranium and cervical vertebrae of *Homo* (n=120), *Pan* (n=114), and *Hylobates* (n=92). Magnitudes of integration (MI) were calculated for each taxon using the mean integration statistic. Although there exist differences in MI between taxa and *Homo* displays generally lower MI than both *Pan* and *Hylobates*, overall patterns of integration are the same. In all three taxa, the cervical vertebrae are strongly integrated with the basicranium (MI=0.78-0.89), often more so than they are with each other or as isolated elements, and vertebrae C3 through C6 form an integrated module (MI=0.84-0.92). These results do not support the hypothesis that the cervical column is evolving in response to locomotor behaviors, but rather suggest the cervical vertebrae evolve in response to changes in cranial morphology. Differences in the cervical column between hominins and other hominoids, thus, are likely the result of the uniquely derived skull of hominins rather than the adoption of bipedalism.

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### Interpreting the Penutian migration through Genetics: Ancient human DNA analysis from Central California

FERNANDO A. VILLANEVA<sup>1</sup>, CARA MONROE<sup>2</sup>, ROSEMARY CAMBRA<sup>4</sup> and ALAN LEVENTHAL<sup>3</sup>

<sup>1</sup>School of Biological Sciences, Washington State University, <sup>2</sup>Laboratories of Molecular Anthropology and Microbiome Research, University of Oklahoma, <sup>3</sup>College of Social Science, San Jose State University, <sup>4</sup>Muwekma, Ohlone Tribe

Living and ethnographic Ohlone groups speak Penutian languages, particularly in the San Francisco Bay area. Penutian populations are thought to have expanded into Central California around 5,000 B.P. from the Columbian Plateau; however it is unclear what effect immigrating Penutian speakers had on the existing Hokan populations. Here, mitochondrial DNA (mtDNA) data was collected from over 300 ancient individuals to further understand the hypothesized spread of Penutian populations from the Columbian Plateau into Central California. We studied ancient individuals alive between 2500-3000 BP, and found distinct maternal lineages belonging to either immigrating Pro-Utian speaking peoples, or to Hokan populations, who had previously lived in the area for over 7,000

years. The presence of both lineages in the same burial population is suggestive of inter-marriage post migration. Furthermore, Bayesian demographic analysis indicates a major population expansion within the region unique to the Penutian lineages, but not the Hokan languages.

### Reconsidering Mid-Pliocene Hominin Ecology in the Turkana Basin, Kenya: Integrating Vegetation, Sedimentary, and Mammalian Community Reconstructions to Explore Hominin Sympatry

AMELIA VILLASEÑOR<sup>1</sup>, ANNA K. BEHRENSMEYER<sup>2</sup> and RENÉ BOBE<sup>3</sup>

<sup>1</sup>Center for the Advanced Study of Human Paleobiology, The George Washington University, <sup>2</sup>Paleobiology, Smithsonian Museum of Natural History, <sup>3</sup>Departamento de Antropología, Universidad de Chile

Recent discoveries of increased hominin diversity and behavioral complexity in the mid-Pliocene are challenging long held assumptions in paleo-anthropology. To better understand how multiple hominin species may have existed sympatrically, this study focuses on middle Pliocene sediments in the Lake Turkana region where both *Kenyanthropus platyops* and *Australopithecus afarensis* fossils have been found. Specifically, vegetation, sedimentation, and faunal community data are analyzed above and below the Tulu Bor Tuff (~3.4 Ma) in East and West Turkana. Vegetation reconstructions are based on carbon and oxygen stable isotope records from soils (West Turkana, n=38; East Turkana, n= 80) and faunal analyses on published, museum, and recent fossil collections (West Turkana, n=963; East Turkana, n=1127). Diversity analyses of both vegetation and mammalian communities show that high vegetation heterogeneity is associated with greater faunal diversity in East Turkana, though the relationship is not statistically significant. Through both time and space, East Turkana has greater variation in vegetation but lower mammalian diversity, as compared to the more wooded-shrubby West Turkana sites, which have a significantly greater number of hominins. Finally, as an asymmetric half-graben, East Turkana sedimentary reconstructions show evidence of a large axial river system that match its greater proportions of edaphic grassland-adapted bovids (e.g., reductinics) as compared to West Turkana. Together, these pieces of evidence paint a picture of geographically close but ecologically distinct regions where West Turkana shows evidence of more homogenous, dry, and woody environments that supported greater abundances and, possibly, multiple species of hominins.

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### Defining *Homo* or identifying *Homo*? The role of the genus in hominin taxonomy

BRIAN A. VILMOARE

Anthropology, University of Nevada Las Vegas

The role of the genus in hominin taxonomy has been highlighted recently by discoveries proposed to be early member of *Homo* (e.g. Berger et al., 2010, Villmoare et al., 2015). Wood and Collard (1999) and Collard and Wood (2007, 2015) proposed that a genus should be a monophyletic group, but only one 'whose members occupy a single adaptive zone'; this would mean removing the earliest specimens now attributed to *Homo*, as they have been inferred not to share the adaptive zone of *Homo erectus* and later species in the genus. Schwartz and Tattersall (2015) agree, and propose using a finite pattern of variation to 'define' the genus, arguing that the present use of the genus *Homo* is overly broad and not in line with broader taxonomic practice.

I examine this hypothesis by contrasting hominin systematic practice with current taxonomies across evolutionary biology, including vertebrates, invertebrate animals, and plants. One clear conclusion is that, with few exceptions, across evolutionary biology, genera are consistently monophyletic, with no attempt to parse more primitive members out. Similarly, there is no specific template of morphological or behavioral diversity. Genera can range from one to more than a thousand, and many genera are remarkably diverse. Because of this, any attempt to 'define' the genus *Homo* is suspect, as modern taxonomic practice requires only synapomorphies for identification of clades at any level, and there is no justification for identifying levels of variation that a genus may not exceed.

### Gravettian human remains from Gargas (Hautes-Pyrénées, France). Implication for biological diversity and mortuary practices during the Upper Paleolithic

SEBASTIEN VILLOTTE<sup>1</sup>, PRISCILLA BAYLE<sup>1</sup>, SELIM NATAHI<sup>1</sup>, CAROLE VERCOUTÈRE<sup>2</sup>, CATHERINE FERRIER<sup>1</sup>, CRISTINA SAN JUAN-FOUCHER<sup>3,4</sup> and PASCAL FOUCHER<sup>3,4</sup>

<sup>1</sup>PACEA, CNRS - Univ. Bordeaux, <sup>2</sup>HNHP, Muséum national d'Histoire naturelle, <sup>3</sup>TRACES, Univ. Toulouse Jean Jaurès, <sup>4</sup>DRAC, Midi-Pyrénées

Gargas (Hautes-Pyrénées, France) is famous for its cave art (paintings and engravings) from the Middle Upper Paleolithic (Gravettian) - about 27,000 years old. The cave has also yielded five human remains from the same period.

The best preserved bone is a partial mandible of a child discovered in 2011, represented by the left half of the body and the left ramus, the symphyseal region and a small portion of the right half of the body. The other human remains are a small fragment of the neurocranium, a deciduous tooth, a fragment of an immature clavicle, and a

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fragment of a small adult femur. The minimum number of individuals is of 3. None of these fragments display anthropogenic traces. Based on the bone morphology and tooth developmental stages, the immature mandible had an age-at-death between 1.5 and 3.5 years. It presents a fused symphysis and an obtuse gonial angle (ca 130°). The anterior symphysis presents a prominent tuber symphyseos and lateral tubercies and the associated mental fossae characteristic of modern humans. Twelve teeth are present, the germ of the lower left permanent canine having an unusual morphology and another one being supernumerary. Interestingly all of the supernumerary teeth known for the Upper Paleolithic are from the Gravettian.

Finding isolated remains of several individuals in a decorated cave links Gargas to other Gravettian sites from southwestern France, where funerary rites seem to have differed significantly from the rich ochre burials found in other Middle Upper Paleolithic sites across Europe.

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### Neanderthal Dental Remains from Chagyrskaya cave, Altai Mountains, Siberia

BENCE VIOLA<sup>1,2</sup>, SERGEY V. MARKIN<sup>2</sup>, NATASHA RUDAYA<sup>2,3</sup>, SERGEY VASILYEV<sup>2,3</sup> and KSENYA KOLOBOVA<sup>2</sup>

<sup>1</sup>Dept. of Anthropology, University of Toronto, <sup>2</sup>Department of Stone Age Archaeology, Institute of Archaeology & Ethnography, Siberian Branch, Russian Academy of Sciences, <sup>3</sup>Department of Archaeology, Novosibirsk State University

The presence of Neanderthals in the Altai mountains of Siberia has been suggested since the 1980s, following the discovery of human remains associated with Middle Palaeolithic industries at Okladnikov and Denisova caves. These remains had few morphologically diagnostic traits, but analyses of mitochondrial and nuclear DNA supported the assignment of some of these fossils to Neanderthals, whereas others belong to another group, the Denisovans. R

Since 2008, our team has been excavating Chagyrskaya cave in the Charysh river valley, about 100 km west of Denisova. The site preserves about 2 m of Pleistocene deposits, which date to the transition between OIS 4 and 3 based on <sup>14</sup>C dates and environmental data. The excavations yielded more than 100,000 lithics and about 150,000 animal bones, as well as 75 hominin fragments.

In this presentation we will focus on the dental remains, which consist of 20 isolated teeth and 7 teeth in mandible and maxilla fragments. The assemblage derives from at least two children and three adults, and it shows a large number of Neanderthal traits in the dentition. These include midtrigonid crests on the lower molars, large and

projecting hypocones on the upper molars, asymmetrical lower fourth premolars and strongly shoveled upper incisors with a convex labial surface.

We will discuss the morphology of these specimens in a comparative context and their implications for our understanding of the easternmost Neanderthals.

### Short Children, Short Lives: Selective Mortality in Preindustrial and Prehistoric Communities

CHYSANTHI VIOLARIS<sup>1</sup> and BETHANY M. USHER<sup>1,2</sup>

<sup>1</sup>Sociology and Anthropology, George Mason University, <sup>2</sup>Students as Scholars, George Mason University

The Osteological Paradox (Wood, Milner, Harpending, and Weiss, 1992), challenged biological anthropologists to acknowledge selective mortality in skeletal samples (among other issues), and to find new methods to identify hidden heterogeneity in cemetery populations. Using a unique approach to compare the stature at death of children to the stature of adults from the same population, our earlier work has demonstrated significant selective mortality in subadults. Children found in Tirup, a medieval Danish rural community cemetery, are shorter than expected, given the height of the adults from the same communities. Estimated stature was calculated from adult (Trotter & Gleser 1958 formulae) and subadult (Ruff 2007 formulae) femur lengths were compared to World Health Organization Growth Standards (<http://www.who.int/childgrowth/en/>), with age-at-death estimated independently using dental development. In this study, we extend this study using publically available data to show similar patterns in agricultural, pre-industrial communities in North America (Irene Mound) and Asia (Ban Chiang, Thailand). In all cemeteries, there is more discrepancy between expected and observed lengths at older juvenile ages (8-15) than in younger children, indicating that children who are already experiencing growth faltering through hunger, illness, or underlying frailty are more likely to die. A weak association is seen with other paleopathological conditions, which may indicate that growth faltering is more predictive of risk of death. Biological anthropologists should be cautious in using subadults from cemeteries as models for the living children in a community.

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### The power of protein: protein regulation, energetics, and health in wild Bornean orangutan (*Pongo pygmaeus wurmbii*)

ERIN R. VOGEL<sup>1,2,3</sup>, TIMOTHY D. BRANSFORD<sup>1,2</sup>, SHAUHHIN E. ALAVI<sup>1,2</sup>, MELISSA EMERY THOMPSON<sup>4</sup>, BROOKE E. CROWLEY<sup>5,6</sup>, WENDY M. ERB<sup>1,2</sup>, MARIA A. VAN NOORDWIJK<sup>7</sup>, SRI SUCI UTAMI ATMOKO<sup>8</sup>, DAVID RAUBENHEIMER<sup>9</sup> and JESSICA M. ROTHMAN<sup>10</sup>

<sup>1</sup>Department of Anthropology, Rutgers University, <sup>2</sup>Center for Human Evolutionary Studies, Rutgers University, <sup>3</sup>Department of Ecology and Evolution, Rutgers University, <sup>4</sup>Department of Anthropology, University of New Mexico, <sup>5</sup>Department of Geology, University of Cincinnati, <sup>6</sup>Department of Anthropology, University of Cincinnati, <sup>7</sup>Department of Anthropology, University of Zürich, <sup>8</sup>Fakultas Biologi and Primate Research Center, Universitas Nasional Jakarta, <sup>9</sup>Charles Perkins Centre and School of Life and Environmental Sciences, University of Sydney, <sup>10</sup>Department of Anthropology, Hunter College of the City University of New York

Protein is essential for growth, maintenance, homeostasis, and reproduction, but the vital role of body protein as an energy source has received little attention in wild primate studies. Our previous research demonstrated that Bornean orangutans in a peatland habitat regulate protein (P) intake while exhibiting extreme variation in non-protein energy (NPe) intake, which is linked to fruit availability. When fruit is abundant, caloric intake increases 3-fold, apparently exceeding energetic needs, and likely increasing fat reserves. However, these reserves may be insufficient to endure extended episodes of fruit scarcity. We hypothesized that increased protein intake is critical for health when fruit is scarce because it serves an energy source. We conducted full-day follows (n=2322) on orangutans in the Tuanan research area in Central Kalimantan, Indonesia (2003-2013). Urinary C-peptide of insulin, ketone bodies, and  $\delta^{15}\text{N}$  were used to quantify energetic state. When fruit was scarce and the P:NPe ratio was highest (p=0.001), orangutans fell into a negative energy balance state, associated with both an increase in P and a decrease in NPe intake. Ketosis was correlated with an increased dietary P:NPe ratio (p=0.001), but was not related to dietary NPe or total calories. C-peptide levels increased with increasing dietary non-structural carbohydrates (p=0.04). Furthermore, orangutans may catabolize body protein for energy via gluconeogenesis during episodes of fruit scarcity, as evidenced by increased urinary  $\delta^{15}\text{N}$  values (p=0.009) when P:NPe was greatest. Orangutans increase protein consumption when fruit availability is low; however, this increase may not provide sufficient energy to prevent tissue wasting.

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## Of Pirates, Pigs and Philistines: A novel perspective on the Late Bronze/Iron Age Transition in the Southern Levant

JULIA AM. KRETZINGER<sup>1</sup>, DOMINIC F. ANDERS<sup>1</sup>, MICHAL ARTZY<sup>4</sup>, ISRAEL FINKELSTEIN<sup>5</sup>, LIORA KOLSKA HORWITZ<sup>6</sup>, PATRICIA SMITH<sup>7</sup>, MARINA FAERMAN<sup>7</sup>, MEIRAV MEIRI<sup>5</sup>, AREN MAEIR<sup>5</sup>, RAGNA STIDSING<sup>4</sup>, GISELA GRUPE<sup>1</sup>, JOSEPH MARAN<sup>3</sup>, PHILIPP STOCKHAMMER<sup>2,9</sup> and MARINA A. VOHBERGER<sup>1</sup>

<sup>1</sup>Biology I Anthropology, LMU Munich, <sup>2</sup>Faculty of Cultural Sciences, LMU Munich, <sup>3</sup>Faculty of Philosophy, University Heidelberg, <sup>4</sup>Recanati Institute for Maritime Studies -Hatter Laboratory, University of Haifa, <sup>5</sup>Institute of Archaeology, Tel Aviv University, <sup>6</sup>Faculty of Jewish Studies, Bar-Ilan University, <sup>7</sup>Laboratory of Biological Anthropology and Ancient DNA, The Hebrew University-Hadassah, <sup>8</sup>Faculty of Life Science, The Hebrew University Jerusalem, <sup>9</sup>Max Planck Institute for the Science of Human History Jena

Across millennia the Mediterranean region of the Levant has been a melting pot of different cultures. During the Bronze Age the interactions between the countries in the area were extraordinarily intense due to flourishing trade relations. At the transition between the Late Bronze and Iron Ages this economic system collapsed due to a complex set of reasons. The so-called "Sea Peoples" are classically described as a group of Aegean invaders who forcefully migrated to various regions in the Eastern Mediterranean. This assumption has been reconsidered in the last years. According to the new hypothesis, the "Sea Peoples", and among them the Philistines, are now seen as non-governmental, transcultural groups of highly mobile actors, of different origins and with shifting identities. Thus, it has been suggested that the Philistines and their culture, are comprised of an amalgamation of various Levantine and non-Levantine populations.

A comprehensive study on human mobility and transcultural dynamics of the Late Bronze Age/early Iron Age has been conducted in the region of modern Israel. The main focus in this part of the project was on three archaeological sites: Tell-es Safi/Gath, Megiddo and Tel Nami. Stable strontium and oxygen isotope analyses of bone and tooth mineral was used for this purpose. Local ranges for the different isotopic systems could be defined, using findings of bones and teeth of domestic pigs from the sites. Results indeed show a high amount of non-local human individuals which supports the hypothesis of increased human mobility.

## Estimating primate morphological ancestors: Implications for the analysis of hominoid cranial evolution

NOREEN VON CRAMON-TAUBADEL and LAUREN SCHROEDER  
Department of Anthropology, University at Buffalo

In recent years, explicit quantitative genetic models have been successfully employed to assess the evolutionary processes underlying morphological diversity among primate taxa. However, when such models are applied to extant taxa, it is often necessary to make assumptions about the direction of evolutionary change by assigning taxa as ancestral and descendant forms. Moreover, methods that test whether among-taxon divergence can be explained by genetic drift or diversifying selection often cannot differentiate between different rates of morphological evolution occurring on two branches issuing from a common ancestor. Here we test the validity of two methods for assessing the average ancestral cranial morphology for each of the hypothetical common ancestors in a fully-resolved phylogeny of 15 extant hominoid taxa. A craniometric dataset comprising 39 traits for a sample of  $n=546$  extant hominoids was used to estimate each average hypothetical ancestor by weighting the traits of the two daughter taxa according to (1) relative neutral genetic branch lengths, and (2) the ratio between Mahalanobis' distances calculated between an outgroup and each pair of ingroup taxa. The two methods produced very similar estimates of average ancestral traits for all nodes, except for the ancestor of the entire hominoid clade, which was closer to the great apes based on method 1 and more gibbon-like based on method 2. Our results demonstrate how such estimated hypothetical ancestors can be employed to identify rates of morphological evolution along each individual branch of a hominoid phylogeny, and identify specific instances of neutral divergence and stabilizing or diversifying selection.

## Men's status and reproductive success in 33 non-industrial societies: effects of subsistence, marriage system, and reproductive strategy

CHRISTOPHER R. VON RUEDEN<sup>1</sup> and ADRIAN V. JAEGGI<sup>2</sup>

<sup>1</sup>Leadership Studies, University of Richmond,  
<sup>2</sup>Anthropology, Emory University

Social status motivates much of human behavior. However, status may have been a relatively weak target of selection for much of human evolution if ancestral foragers tended to be more egalitarian. We test the "egalitarianism hypothesis" that status has a significantly smaller effect on reproductive success (RS) in foragers compared to non-foragers. We also test between alternative male reproductive strategies, in particular whether reproductive benefits of status are due to lower offspring mortality (parental investment) or increased fertility (mating effort). We performed a phylogenetic multilevel meta-analysis of 288 statistical associations between measures of male status (physical formidability, hunting ability, material wealth, political influence)

and RS (mating success, wife quality, fertility, offspring mortality, and number of surviving offspring) from 46 studies in 33 non-industrial societies. We found a significant overall effect of status on RS ( $r=0.19$ ), though this effect was significantly lower than for non-human primates ( $r=0.80$ ). There was substantial variation due to marriage system and measure of RS, in particular status associated with offspring mortality only in polygynous societies ( $r=-0.08$ ), and with wife quality only in monogamous societies ( $r=0.15$ ). On the other hand, the effects of status on RS did not differ significantly by status measure or subsistence type: foraging, horticulture, pastoralism, and agriculture. These results suggest that traits that facilitate status acquisition were not subject to substantially greater selection with domestication of plants and animals, and are part of reproductive strategies that enhance fertility more than offspring well-being.

## Levantine and southern Arabian populations share many Neanderthal SNPs

DEVEN N. VYAS<sup>1,2</sup>, ALI AL-MEERI<sup>3</sup> and CONNIE J. MULLIGAN<sup>1,2</sup>

<sup>1</sup>Department of Anthropology, University of Florida, Gainesville, <sup>2</sup>Genetics Institute, University of Florida, Gainesville, <sup>3</sup>Department of Clinical Biochemistry, Faculty of Medicine and Health Sciences, University of Sana'a, Sana'a, Yemen

Modern humans may have first encountered and interbred with Neanderthals during their dispersal out of Africa. This interbreeding event could have occurred in either the Levant or southern Arabia depending on whether modern humans took a more northern or southern route. We test Levantine and southern Arabian populations to see if they bear the same Neanderthal haplotypes as a way of determining where modern humans first interbred with Neanderthals.

In our analyses, we generated data on 607,938 autosomal SNPs in 90 Yemeni individuals using the Affymetrix Human Origins array. We also collected previously published data from Levantine and other southern Arabian populations, other comparative populations from around the world, and Neanderthal and Denisovan genome sequences. Using this extensive dataset, we identified 1802 Neanderthal SNPs found in previously identified introgressed haplotypes and compared their frequencies in Levantine and southern Arabian populations.

When analyzing all SNPs, Levantine and southern Arabian populations have similar levels of overall Neanderthal ancestry. When we focus on the Neanderthal SNPs identified in introgressed haplotypes, we find that a small percentage of SNPs (~10%) have significantly different frequencies between the Levant and southern Arabia, but the majority of SNPs have similar frequencies in both regions. We speculate that the Neanderthal

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ancestry in Levantine and southern Arabian populations may originate from the same pulse(s) of Neanderthal introgression.

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### Unidentified, multifocal joint disease from the Slovenian Kranj skeletal series

VLASTA VYROUBAL<sup>1</sup>, MARIO ŠLAUS<sup>1</sup>, ŽELJKA BEDIĆ<sup>1</sup>, ANDREJ PLETERSKI<sup>2</sup> and BENJAMIN ŠTULAR<sup>2</sup>

<sup>1</sup>Anthropological Centre, Croatian Academy of Sciences and Arts, <sup>2</sup>Institute of Archaeology, Slovenian Academy of Sciences and Arts

The Župna cerkev cemetery in Kranj contains more than 2100 archaeologically investigated burials dated from the 7<sup>th</sup> to the 18<sup>th</sup> century AD. From these a total of 1169 skeletons were available for detailed anthropological analysis. A large number of skeletons (n=55; 18 males, 34 females, and 3 subadults) exhibit irregular shaped lytic lesions of various sizes (approx. 5-20 mm) on the joint surfaces. The lesions are polyarticular, generally bilateral, and lytic with no new bone formation. Most commonly affected are the knees, ankles, shoulders, elbows and phalanges of the hand. The vertebrae are usually not affected. The lesions were significantly more frequent in females than males (34/406 or 8.4% compared to 18/478 or 3.7%;  $\chi^2 = 7.611$ ,  $P = 0.005$ ). In terms of the age distribution of the disease the affected individuals cover all age groups, the youngest being a subadult of 7-8 years at time of death, while the oldest is a female older than 60 years of age. At this moment the aetiology of the disease is unclear. The lack of osteophytes, peri-articular erosions, osteoporosis, sclerosis of the affected part of the joint and bony ankylosis rules out more recognizable joint diseases such as rheumatoid arthritis, juvenile rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythematosus, psoriatic arthritis, sarcoidosis, osteochondritis dissecans, and gout. The grouping of individuals with the disease in the cemetery does not appear to be random and may reflect a genetic component to the disease.

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### Limb Joint Degenerative Joint Disease Prevalence in German Populations from the Little Ice Age (AD 1300-1850)

ELEANOR J. WADDLE, KENDRA WEINRICH and LESLIE L. WILLIAMS

Anthropology, Beloit College

The Little Ice Age (LIA) was characterized by changing environmental stresses, impacting populations across northern Europe. To understand the effect of these stresses on human activity patterns, we investigated differences in

prevalence of Degenerative Joint Disease (DJD) in limb joints between pre-peak LIA (AD 800-1500) and peak LIA (AD 1500-1850). We hypothesized that limb DJD prevalence was higher during the peak of the LIA compared to the pre-peak period. Global History of Health (GHHP) Standards were used to score DJD in individuals with at least one observable bone in a joint system. We then calculated DJD prevalence in upper and lower limbs, prevalence of moderate/severe DJD (GHHP categories 3-4), and age specific prevalence for adults.

DJD prevalence in both the upper limb (pre-peak LIA: 87.5% (28/32); peak LIA: 72.4% (63/87) likelihood ratio,  $p > 0.05$ ) and lower limb (pre-peak LIA: 93.3% (28/30); Peak LIA: 78.4% (76/97); likelihood ratio,  $p = 0.049$ ) decreased between pre-peak and peak LIA. Though not statistically significant, this pattern was reversed for moderate to severe DJD of the upper and lower limbs. When examining prevalence by age, moderate to severe DJD increases from the pre-peak LIA to the peak LIA across all age categories in both the upper (Pre-peak LIA: 0.0% (0/32); Peak LIA: 2.3% (2/87); likelihood ratio,  $p > 0.05$ ) and lower limbs (Pre-peak LIA: 3.3% (1/30); Peak LIA: 7.2% (7/97); likelihood ratio,  $p > 0.05$ ). These results highlight the complex relationships between environmental factors, activity patterns, and DJD prevalence in the Little Ice Age.

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### Reflecting at 99: Engaging Ethics in the AJPA

JENNIFER K. WAGNER

Bioethics, Geisinger Health System

In 2016 the American Association of Physical Anthropology (AAPA) established a standing Ethics Committee to promote ethical literacy among AAPA members. Ethical literacy, as articulated by Dr. Nancy Tuana (2007), involves sensitivity, reasoning, and moral imagination. Sensitivity is an awareness of or an ability to spot ethical issues. Reviewing the ways in which ethics is engaged in print within the AAPA's official journal offers us an opportunity to assess AAPA membership's ethical literacy. An advanced search was performed on the Access AJPA members-only site, which offers access to every AJPA issue since its premiere issue of Jan/Mar 1918, to identify AJPA items explicitly mentioning ethics content somewhere in the full text. Content analysis was performed on items identified. This systematic review of ~99 years of AJPA issues uncovered 329 initial search results, which included 274 verified and unique items engaging ethics explicitly. Items included full articles with varying levels of coverage of ethics issues (144

or 53%); books reviewed or received (61 or 22%); conference materials such as program information and abstracts for annual meetings (39 or 14%); and other items such as letters to the editor, news and views, obituaries, and brief communications (30 or 11%). Qualitative results are also revealing. Despite limitations of the approach, this reflection provides useful information regarding AAPA's ethical literacy, which can inform future AAPA Ethics Committee activities.

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### Methodological Considerations for Measuring Female Chimpanzee Social Relationships

MONICA L. WAKEFIELD<sup>1</sup>, ALEXANA J. HICKMOTT<sup>2</sup>, LINDSEY M. MEADOR<sup>1</sup>, SYLVIA J. AMSLER<sup>3</sup> and KYLEB D. WILD<sup>4</sup>

<sup>1</sup>Sociology, Anthropology, and Philosophy, Northern Kentucky University, <sup>2</sup>Anthropology, University of Oregon, <sup>3</sup>Anthropology, University of Arkansas at Little Rock, <sup>4</sup>Anthropology, University of California San Diego

Fission-fusion chimpanzees (*Pan troglodytes*) exhibit considerable interindividual and age/sex variation in gregariousness and association patterns. Females at most sites are less gregarious, form smaller parties, and tend to have fewer frequent associates compared to males. Yet, research at several sites suggests that females regularly associate and form active relationships with other females, but this may vary significantly across sites. Differences in data collection and analyses of association patterns can render direct comparisons difficult. Moreover, the methodology used may influence researcher interpretation of social parameters. We use party data from two Kibale communities, Ngogo and Kanyawara, to examine how observation technique (focal-female follows compared to group/male follows) and different measures of association (normalized by sample average vs. randomized dyadic association indices (DAI)) influence our interpretation of sociality among female chimpanzees. We compare the results from data collected during focal-female follows at Ngogo and Kanyawara, and focal-male follows at Ngogo. Based on focal-female follows, Kanyawara females were much more gregarious than previously reported (29% of female-female dyads had greater than expected normalized DAI compared to 40% of male-male Dyads). Similarly at Ngogo, female-female normalized DAI were significantly higher in focal-female follows than focal-male follows ( $t=2.174$ ,  $df=275$ ,  $p=0.03$ ,  $n=276$ ). Compared to randomized indices we found that the normalized DAI exaggerated differences between males and females, pushing more females below expected levels relative to males. Our results emphasize the importance of focal following females and suggest that comparing female social patterns directly to males may systematically

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underestimate female sociability and mask potentially important relationships.

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### States of Being: Exploring Nabataean Nationality

JESSICA WALKER

Anthropology, University of Pittsburgh

The distinction between individual, community, and national identities is often difficult to assess archaeologically, particularly along geographic socio-political boundaries. Bioarchaeological resources provide the most direct record of individual life experiences and may be integrated to effectively address questions related to national identity and the experiential nature of nationality. As the biocultural record of an individual's life, human skeletal remains can reveal inequality and lifestyle differences between individuals and communities. Mortuary practices, which represent metaphysical belief systems, often endure beyond other socio-cultural trends and may be integrated to understand individual group identities on complex socio-political landscapes.

The Khirbet Qazone cemetery (1<sup>st</sup> - 3<sup>rd</sup> century C.E.), encompassing individuals from the Dead Sea periphery of the Nabataean Kingdom in Jordan, evidences diverse individual and community identities. Compared with other Nabataean populations, the Khirbet Qazone skeletons (n=46) demonstrated higher frequencies of stress indicators, such as porotic hyperostosis and dental pathologies, implying differential experiences of stress and access to resources or dietary preferences between communities. Burial practices at Khirbet Qazone also demonstrated variation and indicate that individuals within this marginalized community may have employed elements of the national Nabataean identity selectively, combining aspects of the diverse Roman, Nabataean/Arab, and Jewish milieu evidenced in epigraphic and historical textual resources.

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### Dispersal is socially, but not energetically costly, in female chimpanzees of Gombe National Park

KARA K. WALKER<sup>1</sup>, CARSON M. MURRAY<sup>2</sup> and ANNE E. PUSEY<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University,

<sup>2</sup>Anthropology, George Washington University

Chimpanzees are characterized by an unusual dispersal pattern where most females, rather than males, disperse around sexual maturity. Though costly, emigration eliminates the risk of inbreeding. Across populations, resident females are consistently hostile to incoming females and immigrants primarily associate with males who sometimes intervene in female-female

conflicts. Additional costs have yet to be quantified. Dispersing females lose access to familiar foraging areas and are expected to experience poor diet quality and/or increased foraging effort after transfer. Altered foraging and association patterns may also lead to increased travel time. Finally, more subtle social effects may occur when immigrant females leave behind maternal relatives and established social networks. Together, these costs may have reproductive consequences and delay first birth in immigrant females.

We examined the costs of dispersal for female chimpanzees in Gombe National Park by comparing immigrant (n = 10) and natal (n = 9) females of similar age (10 - 18 years). Diet quality, foraging time and travel time did not differ between immigrant and natal females. Like previously reported, immigrant females received aggression from resident females more frequently than natal females and primarily associated with males. Immigrant females also spent less time in social grooming and more time self-grooming than natal females and had more social partners but lacked close social allies. Dispersing females gave birth 2.5 years later than non-dispersing females. These results suggest that immigrant females do not face substantial energetic deficits during transfer but that a hostile social environment may delay first birth.

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### Cortical Bone Dynamics and Skeletal Age at Death Assessed from Human Femoral Cortical Histomorphology

ROBERT A. WALKER

Anatomy, New York Chiropractic College

Changes with age in human cortical bone histomorphology in the anterior femoral cortex of 173 individuals were examined, including both quantitative and qualitative data. All individuals in the study were documented as to age and sex. Four quantitative histological features were examined in each specimen: secondary osteons per square millimeter, secondary osteon fragments per square millimeter, number of nonhaversian canals per square millimeter, and percent of a one square millimeter field composed of lamellar bone. Qualitative assessment included relative amounts of unremodeled lamellar bone, and resorption and trabecularization of the cortex. Three published methods of age determination from cortical bone histology by means of regression equations were tested, and a new regression equation for this purpose was developed. Each individual was also qualitatively evaluated to assess the biological age of the specimen from cortical bone histomorphology. Such assessments were carried out in the periosteal, middle, and endosteal regions of the section. Qualitative seriation yields correlations with known age (r = .60 -.70) similar to that of quantitative age

estimates based on quantitative criteria, while qualitative seriation of specimens was found to estimate age with greater accuracy and less bias than the regression techniques. Seriation was based on histomorphology of the periosteal, endosteal, and midsection envelopes, and thus assess the whole thickness of the cortex. Periosteal to endosteal examination reveals greater variation. Periosteally, the highest correlations with age are due to haversian remodeling, while in the midsection and endosteally, the highest correlations are with measures of bone resorption.

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### Osteoarthritis as an evolutionary mismatch disease

IAN J. WALLACE<sup>1</sup>, STEVEN WORTHINGTON<sup>2</sup>, DAVID T. FELSON<sup>3</sup>, ROBERT D. JURMAIN<sup>4</sup>, KIMBERLY T. WREN<sup>5</sup>, HELI MAJJANEN<sup>6</sup>, ROBERT J. WOODS<sup>7</sup> and DANIEL E. LIEBERMAN<sup>1</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University,

<sup>2</sup>Institute for Quantitative Social Science, Harvard University,

<sup>3</sup>Clinical Epidemiology Unit, Boston University School of Medicine,

<sup>4</sup>Department of Anthropology, San Jose State University,

<sup>5</sup>Department of Anthropology, University of Tennessee,

<sup>6</sup>Laboratory of Archeology, University of Oulu,

<sup>7</sup>Battelle Memorial Institute

Osteoarthritis (OA) is a pervasive and disabling joint disease whose causes remain poorly understood, but which is commonly attributed to aging and obesity. To gain new insight into the etiology of OA, this study traces the evolutionary history of knee OA in the United States using the largest skeletal sample ever studied of people aged 50 years and older, spanning from prehistoric times to the modern post-industrial era. We show that knee OA long existed at low frequencies, probably due to mostly trauma, but since the mid-20<sup>th</sup> century knee OA has more than doubled in prevalence, has become more common among younger individuals, and is more likely to occur bilaterally. Our analyses refute the view that these changes have occurred simply because people are living longer and are more commonly obese, and instead point to additional independent risk factors that have become widespread in the post-industrial era, including physical inactivity and pro-inflammatory diets. We conclude that recent increases in OA are an example of evolutionary mismatch, caused by the human body being inadequately or imperfectly adapted to modern environmental conditions.

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### The Effects of Human Surrogacy on Hair Cortisol Levels in Orphaned Baboons (*Papio ursinus*)

MICHEL T. WALLER<sup>1,2</sup>, SAMANTHA SKINNER<sup>2</sup>, SARA FARDI<sup>3</sup>, ROBIN M. BERNSTEIN<sup>3,4</sup> and HANNAH YOUNG<sup>5</sup>

<sup>1</sup>World Languages and Cultures, Central Oregon Community College, <sup>2</sup>Department of Anthropology, University of Oregon, <sup>3</sup>Department of Anthropology, University of Colorado, <sup>4</sup>Health and Society Program, Institute of Behavioral Science, University of Colorado, <sup>5</sup>Center of Animal Rehabilitation and Education, South Africa

Because baboons in South Africa are seen as pests, adults are often killed and infants abandoned. Rehabilitation programs often use human surrogates to care for and, in some cases, prepare infants for reintroduction to the wild. The goal of this project was to measure the effects of human surrogacy on the stress levels of orphaned chacma baboons. To accomplish this, hair samples were taken twice (45 days apart) from eight infant baboons at the Center of Animal Rehabilitation and Education (CARE) in South Africa. Initial samples averaged 8.45 ng/mg (range = 1.82-24.81) of cortisol while the second samples averaged 4.82 ng/mg (range = .93-9.55) of cortisol. In fact, cortisol levels decreased by an average of 4.66 ng/mg (range = .68 – 17.61) in seven of the eight individuals sampled. One female saw an increase of 3.54 ng/mg. These preliminary results suggest that human surrogacy can lower stress levels and may play an important role in rehabilitation. Furthermore, the results give us a base level from which to compare stress levels measured after reintroduction.

*This project was supported by an Undergraduate Research Award from the University of Oregon.*

### The Prediction of Human Pigmentation Phenotypes from DNA for Forensic and Anthropological Usage

SUSAN WALSH<sup>1</sup>, KRYSZTA BRESLIN<sup>1</sup>, RYAN ELLER<sup>1</sup>, CHARANYA MURALIDHARAN<sup>1</sup>, EWELINA POSPIECH<sup>2</sup>, LAKSHMI CHAITANYA<sup>3</sup>, ANDREAS WOLLSTEIN<sup>4</sup>, FAN LIU<sup>3</sup>, WOJCIECH BRANICKI<sup>5</sup> and MANFRED KAYSER<sup>3</sup>

<sup>1</sup>Biology, Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, USA, <sup>2</sup>Genetics & Evolution, Jagiellonian University, Kraków, Poland, <sup>3</sup>Genetic Identification, Erasmus MC medical centre, Rotterdam, The Netherlands, <sup>4</sup>Biology II, University of Munich (LMU), Munich, Germany, <sup>5</sup>General Biochemistry, Jagiellonian University, Kraków, Poland

The prediction of human physical appearance traits from DNA has an intelligence driven application in the field of forensic genetics when typical DNA profiling methods fail to provide a match. Forensic DNA phenotyping of pigmentation phenotypes, in particular, eye, hair and skin color, has led the way in this exciting area of research with the design of tools capable of

predicting categorical pigment profiles from DNA collected at a crime scene. Herein also lies its usefulness in anthropological research where it may offer a better understanding of the evolution of pigmentation traits in humans through the restoration of color phenotypes to deceased individuals by the analysis of old and ancient remains (e.g. King Richard III). Currently, categorical eye, hair and skin color tools are capable of high levels of prediction accuracy using published tools, i.e. IrisPlex, HlrisPlex, HlrisPlex-S. However, due to the interpretation issues involved using categorical pigment descriptions, a movement towards the understanding and genetic basis of quantitative color and its prediction is preferred. Using newly developed computer programs that calculate the amount (per pixel) of eumelanin and pheomelanin in photographic imagery together with spectrophotometric data, a more quantitative phenotype description can now be generated. This, in combination with genome-wide SNP data, allows the performance of genome-wide association studies (GWAS) on newly collected datasets of US and European individuals. The goal is to unearth additional variants associated with iris, hair and skin color to improve our understanding of the unique variation between individuals in terms of their pigment palette.

*This work was funded by the National Institute of Justice (award 2014-DN-BX-K031).*

### Urbanizing Medieval London: Temporal Changes in Survivability

BRITTANY S. WALTER

Department of Anthropology, University of South Carolina

The progression of transitional periods, such as urbanization, often produces negative health outcomes as new conditions of the changing environment become more prevalent. For urbanization, detrimental living conditions are assumed to intensify as population density increases, and the failure of a population to adapt to these conditions should be evident in lower rates of survivorship as urbanization increases through time. However, periods of transition are inherently complex, as are humans' attempts to adapt to these changing environments. This study compares temporal changes in survivability in the medieval urban St. Mary Spital cemetery in London ( $n=386$ ) vs. the non-urban St. Peter's cemetery in Lincolnshire ( $n=220$ ) to test the hypothesis that urbanization resulted in temporal declines in survival that did not occur in a contemporaneous non-urban environment. The effect of time period (Early c. 1120-1300 vs. Late c. 1300-1539) on survivability is evaluated within each cemetery, with adults and subadults analyzed separately. Results of Kaplan-Meier survival analysis of adults suggest that for adults in the urban environment, survivorship increased with the intensification of urbanization, but did not change

for non-urban adults. For urban subadults, survivability did not change with increased urbanization, and in contrast, survivorship decreased in the later phase for non-urban subadults. These results may reflect changes in strategies and policies to accommodate sanitation and pollution issues necessitated by increased population density in London. These changes in living conditions may have benefitted adults as urbanization progressed in London, but may not have been as effective for subadults.

*Data for this study were obtained using funding from the National Science Foundation (BCS-1540208 and BCS-1261682), and the University of South Carolina SPARC Grant.*

### Ecology of the Human Gut Microbiome: An Evolutionary Perspective and its Implications for Health

JENS WALTER

Biological Sciences, University of Alberta

Humans are holobionts in that they have co-evolved with complex microbial communities that have shaped all aspects of their host's biology, including their health. This evolutionary process occurred under environmental conditions that determined key selective forces that shaped the establishment of host-specific microbial communities, their stable maintenance, and the emergence and development of mutualistic host-microbiome interactions. In this talk, I will discuss how environmental factors impact gut microbiome structure and function through their influence on basic ecological processes, using a framework based on community ecology theory. I will then use this framework to explore how environmental and lifestyle changes associated with the evolutionary history of humans are predicted to alter their microbiome, and how this information can be used to explain the patterns of the gut microbiota in contemporary humans, such as our own findings obtained with sequencing of the fecal microbiome of uncontacted Amerindians (Clemente *et al.*, *Sci Adv.* 2015 3;1) and rural Papua New Guineans (Martinez *et al.*, *Cell Rep.* 2015 28;11(4):527-38. I argue that a fundamental ecological understanding of the human microbiota in an evolutionary context is instrumental for the interpretation of the microbiome's role in human health, as well as the development of strategies that are aimed at its therapeutic modulation.

### The Rise of an Empire, the Decline of its People: Stature and body proportion in Roman Britain

LAUREN J. WALTHER and REBECCA L. GOWLAND  
Department of Archaeology, Durham University

Stature estimation plays an integral role in assessing the general health and well-being of past populations. Interest in the estimation of

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living stature from past populations can be seen in several areas of study, including economic history, human biology, and anthropology. Currently, the most widely utilized regression formulae for estimating stature of bioarchaeological populations dating to the Romano-British period are those developed by Trotter and Gleser (1952, 1958) and Trotter (1970). Using these formulae, a decrease in stature occurs during the time of Roman rule in Britain. Existing stature estimations of this past population are therefore based on reference populations that are genetically, geographically and temporally far removed.

The aim of this study was to test whether these often cited regression formulae accurately estimate living stature of Romano-British populations. A total of 76 individuals (40 females and 36 males) from five Romano-British sites located throughout the southern and eastern regions of Britain had stature reconstructed using the revised Fully anatomical method.

Stature estimations using the previously mentioned regression formulae were statistically different from those reported using the revised Fully anatomical method, and in a few cases outside the range of standard error. The 'white' formulae from Trotter and Gleser (1952, 1958) and Trotter (1970) overestimated male and female stature, whilst Trotter and Gleser's (1942/1958) 'black' formulae slightly underestimated male and female stature. Difference in body proportions, with particular regard to the vertebral column, are believed to be driving this difference in stature estimation.

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### Female Olive Baboons (*Papio anubis*) Signal Sexual Interest in Socially Stable Males

JESSICA T. WALZ<sup>1</sup> and DAWN M. KITCHEN<sup>2</sup>

<sup>1</sup>Sociology, Criminology, and Anthropology, University of Wisconsin-Whitewater, <sup>2</sup>Anthropology, The Ohio State University

We explored the interactions between competition, coercion, and choice to determine the relative influence of these mechanisms on the expression of female sexual signals and copulatory success in olive baboons (*Papio anubis*). We recorded all interactions between focal females (n=19) and adult males (n=30) in three groups at Gombe Stream National Park over two study periods, and used non-parametric statistics and generalized linear mixed models to test for an effect of male rank, rank trajectory, tenure, age, and aggressiveness on behaviors indicative of mate preference in this species. We found that, around ovulation, females are more likely to solicit males ascending the hierarchy (Mann-Whitney  $U=1.705$ ,  $p=0.088$ ) as well as those who maintain longer tenures, although this varied somewhat across the three groups we considered. These "preferences" translate into higher copulation

rates ( $\beta \pm SE=1.49 \pm 0.51$ ,  $t=2.90$ ,  $p=0.01$ ) and success at consort takeovers ( $\beta \pm SE=3.12 \pm 1.16$ ,  $t=2.70$ ,  $p=0.01$ ) and there is little support that this is simply based on male aggression toward females. However, outside the fertile window, copulations were related to male rank and aggressiveness ( $\beta \pm SE=-13.18 \pm 2.25$ ,  $t=-5.85$ ,  $p<0.01$ ). Overall, our data support hypotheses suggesting female strategies serve as a graded signal that allow females to encourage mating from preferred partners when near conception, but also encourage competition or paternity confusion when not fertile. We highlight important similarities and differences in male and female reproductive strategies across three closely-related savanna baboon species and consider how a synthesis of these unique strategies can help resolve questions about evolved sexual conflicts in the context of complex societies.

*Thanks to the following institutions for contributing to the funding of this project: The Leakey Foundation, International Primatological Society, American Society of Primatologists, Sigma Xi, Animal Behavior Society.*

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### Evidence for Cancer and Syphilis in a Prehistoric Native American Population from North Carolina

CAITLIN N. WAMSER and CHELSEY A. JUAREZ

Department of Sociology and Anthropology, North Carolina State University

A small skeletal population (N≥8) of prehistoric Native Americans from North Carolina was analyzed for evidence of disease. Although the remains were commingled, at least two individuals demonstrated pathological changes to bone. The remains for Individual 1 consisted of a frontal bone demonstrating changes such as lytic lesions, scalloped edges, remodeling, and a moth eaten appearance consistent with carries sicca (Ortner 2003). The lesions are concentrated on the outer and inner tables of bone and in close proximity to each other. Remains for Individual 2 consist of five cranial pieces, one left clavicle, twenty-two vertebral fragments, twelve ribs, and six scapular fragments. These osteological materials demonstrate the following changes; lytic lesions, some with sclerotic edges, scalloped edges, some with remodeling, and a moth eaten appearance. These lesions were more spread out, generally smaller, and on all sides of the bones. Differential diagnosis tables were constructed to compare each element to six different pathologies based on lesion appearance and location. The pathologies included in the table are as follows: multiple myeloma, metastatic cancer, syphilis, yaws, bejel, and tuberculosis. All elements for both individuals were radiographed, and the lesions were photographed macroscopically, microscopically, and measured. With the exception of the frontal bone, all of the elements appeared to have either multiple myeloma or metastatic cancer. Differentiation between these

two pathologies in prehistoric and fragmented dry bone is extremely difficult, but with the help of the differential diagnosis tables, the possibilities were narrowed down to the two most likely pathologies.

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### Mechanical Properties of the Masticatory System in Recent Northern Chinese populations

QIAN WANG<sup>1</sup>, QUN ZHANG<sup>2</sup>, TAO HAN<sup>2</sup>, ZHICHAO SUN<sup>2</sup>, MATTHEW J. KESTERKE<sup>1</sup>, HONG ZHU<sup>2</sup>, PAUL C. DECHOW<sup>1</sup> and QUANCHAO ZHANG<sup>2</sup>

<sup>1</sup>Department of Biomedical Sciences, Texas A&M University College of Dentistry, <sup>2</sup>Department of Archaeology, Jilin University

Recent studies indicate that evolution of the craniofacial skeleton is influenced by dietary behavior, which in turn alters masticatory efficacy and temporomandibular joint stability. In this study, the mechanical properties of the masticatory system in human populations between 500 B.C. and 100 A.D. from Northern China are assessed in context of their craniofacial types and economic modes, including [1] Ancient High Plateau Mongolians (Xindianzi and Jinggouzi), [2] Ancient Central Chinese (Jiangjougou), and [3] Eurasian (Yanghai). Xindianzi and Jinggouzi were pastoral nomads with robust mandibular bodies, wide and short rami, and large joints, while Jiangjougou and Yanghai were agriculturalists having mandibles with gracile bodies, tall rami, and small joints. All populations exhibited heavy use of the anterior teeth. However, all four populations had a ratio of 0.68 in overall weighted muscle efficiency (following Spencer and Demes, 1993) in terms of incisor loading vs. molar loading (indicating relatively higher molar biting efficiency), similar to early *Homo sapiens*. This is smaller than the ratio (0.72) in populations with heavy anterior paramasticatory activities, such as Neanderthals, Eskimo, and Native Americans. These findings suggest that, [1] mechanical efficiency is maintained in highly diversified Northern China historic populations; [2] there are different craniofacial configuration strategies in adaption to heavy anterior tooth loading; and [3] relatively high mechanical efficiency in molar biting coupled with a decreasing joint size in recent human evolution may negatively affect the integrity of the masticatory system, in which the temporomandibular joint could be more easily injured during unilateral loadings.

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### Inferring Hominoid Locomotor Adaptation from Bones: Insights from the Torso Skeleton

CAROL V. WARD and EMILY R. MIDDLETON

Pathology & Anatomical Sciences, University of Missouri

The ability to infer functional signals from bony morphology is central to how paleontologists

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understand the biology, behavior and evolution of fossil animals. The ability to use comparative morphology to make accurate inferences requires beyond simple correlations and consideration of complex relationships among aspects of shape. The study of torso structure and evolution in hominoids highlights some of these issues. Data reveal more variability in torso shape than previously appreciated, highlighting implications for using form to infer function. For example, gibbons have humanlike upper ribs but apelike lower ribs, with lumbar vertebral morphology intermediate between that of monkeys and other extant apes. Furthermore, although the locomotor repertoire of siamangs is most to that of gibbons, their ilia are more like those of orangutans, reinforcing the case that intermediate morphology does not always equate to intermediate behavior. Furthermore, often multiple factors influence overall shape of an anatomical region, such as the interplay of rib curvature, vertebral morphology, and thoracic breadth. Understanding how those relationships vary and covary among taxa is key for interpreting the selective pressures affecting them. Together, data from extant catarrhines and Mio-Pliocene hominoids suggests that hominins may have evolved from an ancestor with more primitive torso morphology, but not necessarily entirely different locomotor behaviors, than extant great apes, altering interpretations of hominin origins. This research highlights the necessity of detailed and thorough investigation of morphology across a wide range of taxa within a clear theoretical framework for interpreting morphology of fossil animals, involving biomechanical, phylogenetic, and behavioral considerations.

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### A rocky start: The conundrum of a post-medieval burial ground in Gibraltar

DEVIN L. WARD<sup>1</sup>, EMMA POMEROY<sup>2,3</sup>, JENNIFER GRANT<sup>4</sup>, SAM BENADY<sup>5</sup>, CLIVE FINLAYSON<sup>6</sup>, MARÍA CRISTINA REINOSO DEL RÍO<sup>7</sup>, JOSÉ MARÍA GUTIÉRREZ LÓPEZ<sup>7</sup> and KEVIN LANE<sup>8</sup>

<sup>1</sup>Department of Anthropology, University of Toronto, Toronto, Canada, <sup>2</sup>McDonald Institute for Archaeological Research, University of Cambridge, Cambridge, UK, <sup>3</sup>School of Natural Sciences and Psychology, Liverpool John Moores University, Liverpool, UK, <sup>4</sup>CONICET - Instituto Nacional de Antropología y Pensamiento Latinoamericano, Buenos Aires, Argentina, <sup>5</sup>Gibraltar Heritage Trust, Gibraltar, <sup>6</sup>Museum of Gibraltar, Gibraltar, <sup>7</sup>Museo Histórico Municipal de Villamartin, Cadiz, Spain, <sup>8</sup>Instituto de Arqueología, CONICET - Universidad de Buenos Aires, Argentina

Excavations in 2014 at the old St. Bernard's Hospital site, Gibraltar, revealed a previously unknown cemetery containing over 200 single and multiple burials. A hospital was founded at this site in 1567 to treat sailors, before a British military take over in 1704 and the building's

conversion into barracks by 1754. It was recon-verted into a civilian hospital and used as such from the 19th century onwards.

Initial results indicate an unusual assemblage: of the 123 more complete skeletons there is a marked predominance of adolescents/young adults (53% aged 15-35 years, vs 14% aged 35-50 years, 4% >50 years, 29% uncategorised adults), as well as a high proportion of males (48%, vs 9% females, 44% indeterminate). Non-adults are represented by only a few isolated elements. The skeletons display a typical range of ailments for the period, but lack perimortem trauma.

This osteological profile would be consistent with either the 16th-17th Century hospice, or 18th century military hospital (with infectious diseases deaths far outnumbering combat deaths). However, three direct 15th century radiocarbon dates directly on the skeletons contradict either scenario. Nitrogen levels would suggest the possibility of a marine reservoir effect, implying a more recent date. This conclusion is also supported by preliminary material culture analysis, consistent with a 16th-17th century date.

Our interdisciplinary project seeks to further address the origin and nature of the burials. On-going isotopic, DNA and material studies analyses will serve to further address these topics and shed light on this major crossroads of post-medieval life.

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### Let them eat corn: Cause-specific mortality and prehistoric population dynamics in transitional environments

AMY L. WARREN<sup>1</sup>, LISA SATTENSPIEL<sup>1</sup> and ALAN C. SWEDLUND<sup>2</sup>

<sup>1</sup>Anthropology, University of Missouri, <sup>2</sup>Anthropology, University of Massachusetts, Amherst

Agent-based models have become widely accepted methodological tools for demographers studying modern populations, but have been used less often as a tool for paleodemographic research. One advantage of such models is the ability to determine the relative impacts of multiple causes of death through time, a task that cannot be easily accomplished using more traditional bioarchaeological or paleodemographic techniques. As part of the larger Artificial Long House Valley project, we have developed a computational model that allows paleodemographic analysis of the simulated populations. The most recent model version incorporates age-specific fertility as well as death by starvation and old age. Analyses of this model reveal interesting variation in mortality trends throughout the study period.

The model simulates the dynamically changing environment in Long House Valley, Arizona from AD 800-1300. The human populations on this reconstructed landscape are heavily influenced by the annual productive potential of the specific plots of land on which they reside. In analyzing the model, we observed marked temporal variability in starvation rates (e.g., rates were highest in AD 850 and AD 1300, lowest from AD 1150-1200) that track environmental changes in the region throughout the study period. Our results demonstrate that agent-based modeling provides a methodology that can assess the relative influence on overall mortality patterns of specific causes of death, such as starvation, that are directly related to environmental transitions. Ongoing research is extending this work to analyze the temporal variation in mortality due to other causes that are more indirectly influenced by environmental variability.

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### Of hybrid mice and hominins: disintegration key to understanding hominin hybrid morphologies

KERRY A. WARREN<sup>1,2</sup>, CHRISTOPHER J. PERCIVAL<sup>3,4</sup>, TERENCE RITZMAN<sup>1,2,5,6</sup>, BENEDIKT HALLGRIMSSON<sup>3,4</sup> and REBECCA R. ACKERMANN<sup>1,2</sup>

<sup>1</sup>Department of Archaeology, University of Cape Town, <sup>2</sup>Human Evolution Research Institute, University of Cape Town, <sup>3</sup>Institute for Child and Maternal Health, Alberta Children's Hospital, <sup>4</sup>The McCaig Bone and Joint Institute, Department of Cell Biology and Anatomy, University of Calgary, <sup>5</sup>Department of Neuroscience, Washington University School of Medicine, <sup>6</sup>School of Human Evolution and Social Change, Arizona State University

Largely due to the success of ancient DNA, we now know that hybridization and introgression among Late Pleistocene hominins occurred frequently. This should be unsurprising given that numerous mammalian taxa hybridize, with hybridization having effects on their genotypes, phenotypes, and ultimate evolutionary success. Using mice as a model of hybrid morphology, we have shown that certain signatures (e.g. significantly large cranial size (heterosis) and intermediate form) are common in intraspecific hybrid mice where parent taxa are of comparable phylogenetic distance. Here, we extend this model to interspecific hybrid mice (more greatly divergent than intraspecific), and show that hybrids have similar differences in form to that seen in the intraspecific mice, but do not have the same level of cranial heterosis. We also use matrix correlations to compare cranial covariance structure (CCVS) of both intraspecific and interspecific hybrids and their parents, and demonstrate significant differences in CCVS. Although CCVS in intraspecific F1 hybrids tends to more closely correlate with one of the parents, this relationship

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becomes less predictable in multigenerational recombinants, with disintegration evident in later generational crosses (e.g. B1s). For interspecific hybrids, correlations between parent and hybrid CCVS are even smaller. Together hybrid studies of size/shape variation, CCVS and non-metric traits, based the mouse model discussed here but also other primate and mammal models, allow us to interpret variation in hominins. We argue that the patterns we see within the Late Pleistocene hominin fossil record (such as in the Oase I mandible) are consistent with intraspecific mammalian hybridization.

*This research is funded by the DST/NRF Centre of Excellence in Palaeosciences (CoE-Pal) and the National Research Foundation of South Africa*

### From whence they came: Identifying natal landscapes using strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) signatures in late prehistoric southwestern Portugal

ANNA J. WATERMAN<sup>1</sup>, ELIZABETH WRIGHT<sup>2</sup>, MICHAEL KUNST<sup>3</sup>, JOÃO LUÍS CARDOSO<sup>4</sup> and DAVID W. PEATE<sup>5</sup>

<sup>1</sup>Natural and Applied Sciences, Mount Mercy University, <sup>2</sup>Archaeology, University of Sheffield, <sup>3</sup>Madrid, German Archaeological Institute, <sup>4</sup>Social Sciences, Alberta University, <sup>5</sup>Earth and Environmental Sciences, University of Iowa

Analyses of  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios in dental enamel from prehistoric humans can identify individuals who spent at least part of their childhoods in a different location. Previously recovered strontium isotope data from 55 humans interned at six Late Neolithic and Copper Age burials in the Estremadura region of Portugal near the Late Prehistoric settlement site of Zambujal found five total migrants in two of the burials. However it was not possible to identify homelands for these individuals as local values from other regional settlements sites have not been clearly defined. New  $^{87}\text{Sr}/^{86}\text{Sr}$  data from fauna recovered from the late prehistoric Portuguese settlement site of Leceia, which lies approximately 50km south of Zambujal, matches that of three of the five migrants. This suggests Leceia as a possible point of origin for these migrants. Several domesticated animals recovered from Zambujal also exhibit the Leceia local signature suggesting that both people and animals were moving between these settlements. The archaeological record for late prehistoric societies in Portugal suggests some form of chiefly cycling, in which large population centers formed, flourished, and then suddenly declined. Though researchers assume that population migration and trade played important roles in this cycling, very little is known about specific movements of people and animals. This research begins the process of tracing regional migration patterns.

### Stable Isotope Reconstruction of Maladaptive Breastfeeding and Weaning Practices in a 19th Century Rural Dutch Community: The Effect of Possible Negative Nitrogen Balance on Stable Nitrogen Isotope Values

ANDREA L. WATERS-RIST and MENNO L.P. HOOGLAND  
Archaeology, Leiden University

Isotopic reconstruction of breastfeeding and weaning practices is based on 51 skeletons under the age of five years from the predominately 19<sup>th</sup> century rural Dutch cemetery of Middenbeemster. The sex and age-at-death of over half of these subadults is identified from cemetery archives. An intra-long bone sampling strategy, targeting different growth areas of growing long bones, is used to capture stable nitrogen ( $\delta^{15}\text{N}$ ) and carbon ( $\delta^{13}\text{C}$ ) isotope values deposited at different ages. There is scant evidence for breastfeeding even amongst infants aged one to twelve months (n=11), in whom a breastfeeding signal in the form of enriched  $\delta^{15}\text{N}$  values should be clearly evident in newly deposited metaphyseal bone collagen. No infants aged six months to three years (n=14) have meaningful (>0.5‰) elevation of metaphyseal compared to diaphyseal  $\delta^{15}\text{N}$  values. This suggests that exclusive breastfeeding was either of short duration or possibly not undertaken at all. Dairy farming was the main occupation and cow milk was likely used in place of breastmilk. A high prevalence of infants with rachitic lesions is posited to be partly the result of maladaptive infant feeding practices. Keeping in mind that results are from deceased individuals whose frailty may be a result of many factors, maladaptive infant feeding practices contributing to negative nitrogen balance are investigated for their effect on  $\delta^{15}\text{N}$ . Isotopic comparisons of known age subadults of different length, feeding status, and rickets occurrence, suggest that negative nitrogen balance either did not occur or did not alter  $\delta^{15}\text{N}$  values.

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### Developmental limb element asymmetry across three Native North American populations

ERIN B. WAXENBAUM<sup>1</sup> and KENDRA A. SIRAK<sup>2</sup>

<sup>1</sup>Anthropology, Northwestern University, <sup>2</sup>Anthropology, Emory University

Cross-population comparative studies allow us to better appreciate variation both within and across groups by providing a window into varying developmental origins and trajectories. Previous research has found that while symmetric development is the genetically programmed ideal, phenotypic bilateral asymmetry (BA) is common. Insight into how and when limb asymmetry

differs within and across populations can suggest what external stressors, including nutrition, pathology or culturally-specific mechanical demands, contribute to adult form.

Previous research concluded that right-biased BA increases over the course of development most notably in the upper limb, likely resulting from habitual manual engagement. This study assesses whether a similar pattern is appreciated across other populations of distinct culture.

We explore BA in the long bones of Ancestral Puebloan (n=197), Native Alaskan (n=208) and South Dakota Arikara (n=296) groups. Maximum length measurements of the humeri, radii, femora, and tibiae were assessed for individuals divided into five age categories. Significant levels of right-biased BA increasing across development were found in the humerus (p<0.0001) in all populations. Among adults of each population, significant BA was found for both the humerus (p<0.001, right-biased) and the femur (p=0.0076, left-biased). Frequency distributions reveal strong directional trends of asymmetry that become more prevalent and exhibit greater percent differences as age increases favoring the right side of both upper limb elements, with weaker trends seen for lower limb bones. These results suggest that asymmetry in the long bones is shaped by environmental stressors experienced over development that reduce an organism's ability to produce symmetric morphological traits.

### Trabecular Bone Morphometrics: A Methodological Appraisal of Software Applications

NICOLE M. WEBB<sup>1,2,3</sup>, YIZHONG HU<sup>4</sup> and X. EDWARD GUO<sup>4</sup>

<sup>1</sup>Dept. of Anthropology, Graduate Center, CUNY, <sup>2</sup>New York Consortium in Evolutionary Primatology, NYCEP, <sup>3</sup>Dept. of Anthropology, Lehman College, <sup>4</sup>Dept. of Biomedical Engineering, Bone Bioengineering Laboratory, Columbia University

The ability of trabecular bone to remodel when subjected to mechanical loading makes it valuable for inferring locomotor behavior from skeletal material. Although the inherent complexity of accurately assessing functional adaptations using trabecular bone microarchitecture has been reviewed extensively in the literature, the consistency of morphometric parameters across different software packages is less studied. Since scaling protocols are often derived from these parameters, variation among them can influence analyses and their reproducibility across studies. As such, we offer a direct comparison of the variation observed in the outputs of three programs, including both freely available, open source packages and commonly used commercial software.

6.8 x 6.8 x 6.8 mm<sup>3</sup> samples of trabecular bone were digitally segmented from microCT scans of the superior acetabulum of terrestrial mammals

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(n=20) at a resolution of 60µm. Each sample was repeatedly analyzed for differences within and between BoneJ, VGStudio MAX 2.2, and a SCANCO Medical software-based analysis called Individual Trabeculae Segmentation (ITS). Our investigation reveals variability in standard measures such as mean trabecular thickness, with differences as high as 36% (.12 mm) between programs. The degree of anisotropy, calculated using mean intercept length, was comparable for the VGStudio MAX 2.2 built-in morphometrics and the standard BoneJ anisotropy (DA) calculation. The BoneJ basic parameters and alternative tDA outputs were more variable compared to the other softwares, suggesting that individual sample averages should be used. Implementing rigorous resampling protocols that account for this variation can reduce statistical bias introduced during trabecular analyses.

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### The effects of high speed and weighted walking on head pitch and knee forces

JAMES T. WEBBER and DAVID A. RAICHLIN  
School of Anthropology, University of Arizona

Previous research suggests that humans have derived skeletal adaptations which aid endurance terrestrial locomotion. Two adaptations, enlarged hindlimb joint surfaces and expanded posterior semicircular canals, have been used to support the hypothesis that fossil hominins engaged in endurance running behaviors. Large joints dissipate high impact forces that travel up the limb during running. These same impact forces likely affect head pitch which enlarged semi-circular canals may accommodate. However, human endurance locomotion encompasses a range of behaviors including high-speed walking and load carrying that could produce forces similar to running. Here, we test the hypothesis that these understudied behaviors lead to loads and kinematics similar to those experienced when running by examining knee forces and head pitch during high-speed, weighted walking. Subjects (n=5) were filmed using a high-speed motion capture system and wore an accelerometer on their distal femur while walking at two speeds (Slow=1.2 m/s, Fast=2.2 m/s), carrying three different loads (unweighted [U], Light [L]=15% of bodyweight, Heavy [H]=30% of bodyweight). Participants also completed one unweighted running (2.7 m/s) trial. A linear mixed effects model with Bonferroni adjusted post hoc tests found no differences in rates of head pitch between running and fast walking trials ( $U p=0.235$ ,  $L p=1.000$ ,  $H p=1.000$ ). The estimated vertical force at the knee was also similar between fast walking and running ( $U p=1.000$ ,  $L p=0.587$ ,  $H p=1.000$ ). Thus, forces thought to produce running-specific adaptations appear within the range of human walking behaviors.

### The zygomatic root in recent and fossil hominids

GERHARD W. WEBER<sup>1,2</sup> and VIKTORIA A. KRENN<sup>1,2</sup>  
<sup>1</sup>Dept. of Anthropology, University of Vienna, <sup>2</sup>Core Facility for Micro-Computed Tomography, University of Vienna

Shape and position of the zygomatic root are crucial for determining the overall strength of the face in response to bite forces. The zygomaticoalveolar crest (ZAC) is also discussed as a buttressing feature of the face. We examined the morphology of this maxillary region using 3D Geometric Morphometrics based on five landmarks and three curves with semilandmarks on the dental arch and the zygomatic root. A large spectrum of hominids was included. Nevertheless, the results showed a striking overlap in shape variation. We could not find a pattern of shape that would allow separating different hominid groups with confidence, except two extreme forms: Paranthropines and Neanderthals. An obvious general trend of shape changes over time was absent. Modern human shape distribution overlaps with Australopithecines, Habilines, Erectines, Middle Pleistocene *Homo*, and as well with Great Apes. However Apes and Australopithecines lie at opposite poles of the distribution, indicating mainly a more curved or straight ZAC. Paranthropines form a separate cluster for their high and steeply inclined ZAC, broad postcanine tooth row, and forwardly positioned zygomatic root. Differently, Neanderthals feature a backwardly positioned zygomatic root but moderate ZAC height. Atapuerca 5 and Kabwe 1 plot close to Neanderthals. Early anatomically modern humans express a shape between Neanderthals and modern humans, but much closer to the latter. The predominant pattern of variation is in agreement with the idea of a general "Bauplan" for the architecture of this crucial maxillary region. The approach allows simple measurements to distinguish two extreme forms.

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### Out of the Mouths of Babes: Cementum Annulations in Human Deciduous Teeth

VICKI L. WEDEL<sup>1</sup> and KEN P. HERMSEN<sup>2</sup>

<sup>1</sup>Anatomy, Western University of Health Sciences, <sup>2</sup>School of Dentistry, Creighton University

Dental cementum binds teeth in their sockets via the periodontal ligament and is secreted in pairs of bands annually. Age at death in adults can be determined from the total number of cementum annulations, however, it is not yet known if total cementum annulations correlate with age at death in subadults. This study tests the hypothesis that the alternating light and dark bands of cementum observed in adult teeth are present in deciduous teeth. It is further hypothesized the

total number of pairs of cementum bands (light and dark) correlates with age at death, or in this case age at extraction. To test these hypotheses, deciduous teeth were collected with consent from pediatric patients at Creighton University's School of Dentistry in Nebraska.

The study sample consists of 76 teeth collected between March, 2014, and June, 2016, from fifty children aged 4 to 16 years old. The sample included incisors, canines, and molars. Each tooth was embedded, sectioned at the middle third of the root, ground, polished, and imaged. Seven teeth were excluded for inadequate root structure. Alternating dark and light cementum annulations were visible in all but one tooth. The number of pairs of bands plus the age at which the tooth erupted is significantly correlated with age of tooth extraction ( $p<0.01$ ). Future work will include deciduous teeth with partially resorbed roots and a sample representative of the mixed dentition seen in children.

*This study was funded by a Creighton University George F. Haddix President's Research Award.*

### Cranial Vault Modification as a Possible Ethnic Marker in the Middle Cumberland Region

GREG J. WEHRMAN

Anthropology, The University of Tennessee-Knoxville

Cranial vault modification (CVM), a cultural practice that can result in a variety of cranial shapes, has been treated as an ethnic marker among groups in which the practice either differs or is absent. Recent biodistance analyses of Mississippian sites within the Middle Cumberland Region (MCR) of central Tennessee suggest that early sites within this period experienced extralocal gene flow. The present study examines whether cranial shape differences exist among sites in the MCR. Samples were taken from the Arnold (n=21), Bowling Farm (n=17), and Averbuch (n=46) skeletal collections. Since it is often difficult to distinguish slight modification from natural variation in these samples, a morphometric approach was used to distinguish cranial shape differences among sites. Using high-resolution 3D models generated by a NextEngine 3D Scanner, coordinate data were extracted from cranial landmarks, after which a generalized Procrustes analysis was performed in order to control for size and orientation. A principal components analysis was then performed, which explains the magnitude and directionality of changes in landmark distributions. Finally, a discriminant function analysis was performed to classify crania by site. Results indicate that significant shape differences exist among sites in the MCR based on cranial shape variation. In conjunction with results from regional biodistance analyses, this project's results suggest that the variation in shape by site may be explained by

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early coalescence in the region or the presence of migrant groups.

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### Prevalence of Degenerative Joint Disease and Schmorl's nodes in Little Ice Age German populations

KENDRA WEINRICH, ELEANOR WADDLE and LESLIE L. WILLIAMS

Department of Anthropology, Beloit College

Skeletal markers of vertebral osteoarthritis, including osteophytosis, eburnation, and joint surface porosity, are commonly used to reconstruct population activity patterns. The cervical, thoracic, and lumbar vertebrae of three medieval and post-medieval German populations were analyzed to determine the prevalence and severity of degenerative joint disease (DJD) and Schmorl's nodes during the apex of the Little Ice Age (AD 1500-1850). We assess whether activity patterns intensified during this phase of climate related resource scarcity, hypothesizing that the prevalence of degenerative joint disease and Schmorl's nodes will increase in comparison to earlier periods (AD 800-1500). Vertebral bodies were scored according to Global History of Health Project Standards; Schmorl's nodes were quantified by individual.

Thirty-four individuals from the pre-peak LIA and 90 individuals from the peak LIA had vertebrae present for analysis. The prevalence of vertebral DJD decreases from the pre-peak LIA (50%) to the peak LIA (44.4%). This pattern is maintained through all adult age categories: younger adult (pre-peak LIA: 36.4% (4/11); peak LIA 33.3% (5/15)), middle adult (pre-peak LIA 81.8% (9/11); peak LIA 59.1% (13/22)), and older adult (pre-peak LIA 75% (3/4); peak LIA 75% (12/16)). None of these differences were statistically significant. Schmorl's node prevalence (pre-peak LIA: 36.4% (12/33), peak LIA: 41.1% (37/90)) increased between the two time periods, though these differences also were not statistically significant. Therefore, our data do not support our hypothesis and suggest a more intricate relationship between activity patterns and the resource stresses of the LIA than previously thought.

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### Skeletal Height Estimation in Medieval Bioarchaeological Collections from Piedmont, Italy

NICOLE M. WEISS<sup>1</sup>, GIUSEPPE VERCELLOTTI<sup>1</sup>, ROSA BOANO<sup>2</sup>, MARILENA GIROTTI<sup>2</sup> and SAM D. STOUT<sup>1</sup>

<sup>1</sup>Anthropology, The Ohio State University, <sup>2</sup>Scienze della Vita e Biologia dei Sistemi, Università degli Studi di Torino

The anatomical method for estimating stature produces the most accurate results because all skeletal elements that contribute to height are incorporated in the estimates. However, when remains are fragmentary, regression equations describing the relationship between a particular skeletal element and total height can instead be used. This relationship differs amongst populations, and it is therefore imperative that population-specific equations are developed in order to obtain accurate estimates. This study reports new formulae for estimating skeletal height from long bones derived from two medieval (7th – 15th c.) bioarchaeological assemblages from Piedmont, Italy (San Lorenzo di Alba, N=19, and San Michele di Trino, N=51). Previous research found significant status-related differences in long bone lengths, skeletal height, and body proportions in this region (Vercellotti et al., 2011). Therefore, we tested for differences by status and site, with significant differences observed in long bone lengths, skeletal height, and body proportions between males of high and low status in both the Alba and Trino samples ( $p < 0.05$ ). No significant differences were observed between the two sites amongst individuals of the same sex and status; therefore, same sex and status samples were combined to increase sample sizes for developing regression equations. Three sets of formulae (females, low status males, and high status males) were developed for estimating skeletal height from long bone lengths. These formulae are the first specifically developed for use in bioarchaeological samples of known socioeconomic status and may prove useful for developing skeletal height estimates in contemporaneous, socially stratified Italian assemblages.

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### Population genetics analysis of Southeast Asian Ovalocytosis in a cohort of individuals from Island Melanesia

ELIZABETH A. WERREN<sup>1</sup>, HEATHER L. NORTON<sup>2</sup> and ABIGAIL W. BIGHAM<sup>1</sup>

<sup>1</sup>Anthropology, University of Michigan, <sup>2</sup>Anthropology, University of Cincinnati

Malarial infection has been a major selective pressure on the human genome. This has led to the evolution of variable resistance mechanisms in humans, mainly in the form of hematologic disorders. A well-characterized malaria resistance allele found in individuals with Austronesian ancestry is a 27-bp deletion in the Band 3 protein-encoding gene *SLC4A1*. The deletion results in the formation of abnormal, oval-shaped erythrocytes, known as Southeast Asian Ovalocytosis (SAO). SAO erythrocytes confer protection against malaria by disrupting cytoadherence. However, potential frequency of the deletion is constrained by its lethal homozygous state. Previous evidence suggests SAO is under balancing selection in certain Austronesian

populations. Island Melanesia is comprised of Austronesian and Papuan-speaking inhabitants whose ancestors independently migrated to the region ~5,500 and 50,000 years ago, respectively. We genotyped 452 Melanesian individuals with varying amounts of Austronesian ancestry to characterize the allele frequency distribution of the SAO deletion (24 from Lavongai, 195 from New Britain, 98 from New Ireland and 135 from Bougainville). The Austronesian population of Lavongai displayed the highest observed deletion frequency at 16.7%. We also observed the deletion in Papuan-speaking populations (Bougainville, New Britain, New Ireland) at a total frequency of 3.8%, indicating gene flow with surrounding Austronesian groups. To assess the role of selection in maintaining SAO among Island Melanesians, we DNA sequenced the exonic portions of *SLC4A1*. We applied standard population genetics tests to detect evidence of natural selection. Our results shed further light on the combined role of gene flow and natural selection in upholding SAO.

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### Obesity affects the accuracy and precision of age at death estimations based on the pelvic joints

DANIEL J. WESCOTT and SOPHIA R. MAVROUDAS  
Anthropology, Texas State University

Body mass is a factor that can affect individual rates of progression through macromorphological age-related stages of the pelvic joint surfaces. Over the past several decades the rate of obesity has increased dramatically. Therefore, it is necessary to examine the effect of obesity on the accuracy and precision of age-related morphological changes in the auricular surface and pubic symphysis. A documented sample of 250 adults (23-69 years of age) were scored using the Suchey-Brooks method for the pubic symphysis and Buckberry-Chamberlin method for the auricular surface. The sample was divided into normal body mass (BMI 19 - 25) and obese (BMI  $\geq 30$ ). Statistical analyses were conducted to test the affect of obesity on the validity of these methods. Compared to the normal BMI sample, there is a lower correlation between known and estimated age for the obese sample, especially when using the auricular surface. There is also greater bias and inaccuracy in the age estimate for the obese compared to the normal BMI individuals. For young and middle aged adults, the ages of transition from one stage to the next for the auricular surface are lower but have a greater standard deviations for the obese group than the normal BMI group. This study demonstrates that age-related skeletal changes of the pelvis are effected by obesity, and forensic anthropologists should use caution when estimating age-at-death using pelvic joints for obese individuals.

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### The Genomic History of the First Australians

ANNA-SAPFO MALASPINAS<sup>1,3,4</sup>, MICHAEL C. WESTAWAY<sup>2</sup>, SANKAR SUBRAMANIAN<sup>2</sup>, JOANNE WRIGHT<sup>2</sup>, LAMBERT DAVID<sup>2</sup> and ESKE WILLERSLEV<sup>1,5,6</sup>

<sup>1</sup>Centre for GeoGenetics, Natural History Museum of Denmark and University of Copenhagen, <sup>2</sup>Research Centre for Human Evolution, Griffith University, <sup>3</sup>Institute of Ecology and Evolution, University of Bern, <sup>4</sup>Switzerland and Swiss Institute of Bioinformatics, Lausanne, <sup>5</sup>Wellcome Trust Sanger Institute, Wellcome Genome Campus, Hinxton, <sup>6</sup>Department of Zoology, University of Cambridge

Reconstructing the population history of Aboriginal Australia has in the past been limited to investigations of the fossil human record and, more recently, the analysis of mtDNA. Understanding the origins of the First Australians through the analysis of complete genomes holds the potential to provide important new insights into the initial dispersal of *Homo sapiens* from Africa, but also for our understanding of the development of further population structure in ancient Australia. We have generated high-coverage genomes for 83 Aboriginal Australians and 25 Papuans from the New Guinea Highlands and identified a) Aboriginal Australians and Papuans diverged from Eurasians 51–72 kya, following a single out-of-Africa dispersal, and subsequently admixed with archaic populations b) Papuan and Aboriginal Australian ancestors diversified 25–40kya, suggesting pre-Holocene population structure in the ancient continent of Sahul, c) Aboriginal Australians descend from a single founding population that differentiated ~10–32 kya and d) population expansion occurred in northeast Australia during the Holocene. The results of our research provide a new population history for Ancient Australia.

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### Does a Notecard “Cheatsheet” Help Bio Anth Students on Exams?

JESSICA L. WESTIN

Math/Science Department, Kirkwood Community College

Student test anxiety may be lessened by allowing students to use a “cheatsheet” to record vocabulary or specific details that they fear they may forget during an exam. Many instructors feel strongly that the positives of allowing such a test aid (e.g., reducing anxiety, increasing confidence) outweigh the negatives (e.g., abdicating responsibility for knowing elementary details), while others value the importance of basic content and instead require students to memorize vocabulary or details for exams. One may argue that the course level or the intended audience will influence one’s policies in this regard. For example, in

an introductory biological anthropology course, taught almost exclusively to non-majors, allowing a “cheatsheet” may be a way to steer students to understanding and remembering big picture concepts and prevent them from stressing over little details. Additionally, allowing a “cheatsheet” may help instructors to move past the low level Bloom’s categories of “remember” and “understand,” to higher level “analysis” and “evaluation.” Before deciding to use a “cheatsheet,” an important question to ask is, does a “cheatsheet” really help students? Do exam scores improve when students use “cheatsheets”? Is student test anxiety lessened? Here I present results from a pilot study of the effects of “cheatsheet” use on student exam scores, and on self-reported test anxiety in an introductory biological anthropology course, Human Evolution, at Kirkwood Community College in Cedar Rapids, Iowa. Results of this research have the potential to inform decision-making regarding “cheatsheet” use across biological anthropology courses, and hopefully to improve student success.

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### Insights from Neandertals and beyond: Evolution of the hominin microbiome on a global scale

LAURA S. WEYRICH<sup>1</sup>, KEITH DOBNEY<sup>2</sup> and ALAN COOPER<sup>3</sup>

<sup>1</sup>Department of Genetics and Evolution, University of Adelaide, <sup>2</sup>Archaeology, Classics and Egyptology, University of Liverpool, <sup>3</sup>Department of Genetics and Evolution, University of Adelaide

Interpreting the evolutionary history of microbial communities within the human body (microbiota) is key to understanding how microbiota-associated diseases arose in modern humans. DNA sequencing of preserved dental plaque (calculus) from ancient hominin skeletons now provides a unique opportunity to examine the evolution of microbiota and disease through time. We utilized a shotgun sequencing approach to obtain ancient microbial DNA from the dental calculus of European Neandertals, ancient humans from Europe, North America, Asia, and Africa, as well as African great apes to examine how these diverse microbial communities have adapted to shifts in lifestyle, diet, and environment over the past 40,000 years. We reconstructed the first oral microbiota of an extinct species (Neandertals), and reveal nearly 200 bacterial species shared within ancient hominins. We then identified large shifts in the oral microbiota of different hunter-gatherer communities on different continents, revealing information on how microbial communities respond to alterations in diet and environment around the globe. For example, we observe significant shifts in microbiota linked to meat, carbohydrate (sugar), and lactose consumption

through time in different environments. Lastly, we find marked alterations in microbiota when European colonialists arrived in foreign lands, revealing microbiota alterations that are linked to past human interactions. Together, these data provide the first record of human microbiota evolution in real-time, and a means to understand why certain bacterial communities are now linked to disease in a modern world.

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### Bilateral Variation in Human Lumbar Zygapophyses

KATHERINE WHITCOME

College of Health Sciences, California Northstate University

We often expect the size and shape of bilateral joints with postural and locomotor relevance to be symmetrical. This expectation underlies reliance on either right or left elements to be representative of the pair. Here we compare axial lumbar zygapophyseal variation among humans and extant apes to assess how much bilateral variation is present in lumbar facet surface area and orientation. Osteometric data were collected from the lumbar vertebrae of adult skeletons representing an equal number of males and females. Samples include 24 complete lumbar spines of *Homo*, *Pan*, *Gorilla*, *Pongo* and *Hylobates*. Univariate and multivariate analyses of raw and geometric mean shape variables indicate that in transferring load the paired zygapophyses function as a unit. Given that they are relatively close to one another with little interzygapophyseal distance, load is not likely to be supported or transferred by one facet but rather both. Thus, in load transfer studies, total zygapophyseal area should be quantified, even among the relatively long lumbar spine genera of *Homo* and *Hylobates*.

*This study was funded by the University of Cincinnati and The Charles Phelps Taft Research Center at the University of Cincinnati.*

### Growing Pains: Developmental origins of tuberculosis and periodontal disease in Lisbon’s working poor during the turn of the 20th century

JACOB C. WHITE

Archaeology, Durham University

Research on developmental origins of disease typically focuses on growth disruptions and their associations with ‘western’ degenerative diseases. This focus ignores aspects of health, like infectious disease, which have been more important for people throughout human history. Therefore, more research should look at the developmental origins of infectious diseases to learn about growth disruptions’ effect on immunocompetence. Tuberculosis and periodontal

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disease are chosen as proxies for immune functioning because they have a known co-morbidity and include immune suppression as a risk factor. Furthermore, since tuberculosis, a re-emerging infectious disease, and periodontal disease are correlated with degenerative diseases, they have a contemporary significance. This study analysed the skeletal remains of 151 individuals housed in the Lisbon Identified Skeletal Collection to represent a society during changing socio-political periods. This collection has information such as individual's cause of death and occupation, which was used to determine if they had tuberculosis and find socioeconomic determinants of health. The indicators for growth disruptions used were long bone lengths, proximal/distal limb proportions, vertebral neural canal diameters, and vertebral measurement indices. Correlations were found for growth disruptions between sexes and causes of death. These findings show that Portuguese's patriarchal society negatively affected female health. Moreover, developmental origins of disease are an appropriate concept when looking for cause of death. This study suggests future research should focus on the appropriateness of using proximal/distal limb proportions as an indicator for growth disruptions.

### Deflating the "Good Genes Hypothesis": Asymmetry may not be an honest indicator of genetic quality in humans

JULIE D. WHITE<sup>1</sup>, ARSLAN A. ZAIDI<sup>1,2</sup>, CHRISTINA M. BERGEY<sup>1</sup>, TOMAS GONZALEZ-ZARZAR<sup>1</sup>, PETER CLAES<sup>3</sup> and MARK D. SHRIVER<sup>1</sup>

<sup>1</sup>Anthropology, Pennsylvania State University,

<sup>2</sup>Biology, Pennsylvania State University, <sup>3</sup>ESAT/PSI - UZ Leuven, MIRC - iMinds, Medical IT Department, KU Leuven

In humans, the "Good Genes Hypothesis" predicts that facial symmetry is an indicator of superior genetic quality and is supported by reports that more symmetrical faces are rated as healthier. However, the link between symmetry and genetic quality has not been tested using genome-wide genetic markers. To do this, we test whether genetic quality, measured by the proportion of deleterious alleles, predicts average facial asymmetry in a sample of 1,641 European-derived individuals. Asymmetry was calculated as the Euclidean distance between 7,250 quasi-landmarks placed on original and reflected 3D facial images. Genetic quality was assessed by annotating 535,143 genome-wide SNPs using SIFT, which predicts the extent to which an amino acid substitution affects protein function. For each of 2,354 deleterious mutations, an additive model was used to calculate the number of deleterious alleles possessed by each individual. Average asymmetry was regressed on the proportion of deleterious alleles as well as age, sex, height, weight, and the first five genetic

principal components (to correct for population substructure). Our results show that the proportion of deleterious alleles does not predict average asymmetry ( $t=0.112$ ,  $p=0.9108$ ), but age ( $t=11.293$ ,  $p=2 \times 10^{-16}$ ), sex ( $t=-2.127$ ,  $p=0.0335$ ), height ( $t=3.414$ ,  $p=0.0006$ ), and weight ( $t=-3.348$ ,  $p=0.0008$ ) do. Thus, while symmetry may play a role in human mate choice, the relationship between symmetry and genetic quality is likely nuanced and may not be as straightforward as the "Good Genes Hypothesis" predicts. To understand this nuanced relationship, we are exploring other measures of genetic quality as well as other potential influencers of asymmetry.

### Craniofacial Variation in Middle Pleistocene Hominins

SUZANNA WHITE<sup>1</sup>, SIMON HILLSON<sup>1</sup> and CHRISTOPHE SOLIGO<sup>2</sup>

<sup>1</sup>Institute of Archaeology, University College London,

<sup>2</sup>Department of Anthropology, University College London

Middle Pleistocene hominins have been found across the Old World, and document a wide range of craniofacial morphology within a relatively small sample. These fossils are frequently classified as *Homo heidelbergensis sensu lato (s.l.)*, yet some researchers believe that this grouping introduces more variation than should be expected in a single hominin species. This paper aims to investigate the taxonomic status of the Middle Pleistocene hominins, and address two hypotheses: that the craniofacial variation in *Homo heidelbergensis s.l.* is less than or equal to that found in a single, widespread Catarrhine species; and that any divisions within this group are not comparable to those found between Catarrhine subspecies.

A 3D geometric morphometric method is employed, involving the placement of landmarks and semilandmarks on and around the supraorbital torus, due to its high preservation and phylogenetic utility, both within Primates and Middle and Late Pleistocene hominins. The comparative sample consists of over 800 specimens from *Homo*, *Pan*, *Gorilla*, *Papio* and *Macaca* species and subspecies, as well as ten disputed *Homo heidelbergensis s.l.* Results confirm both hypotheses: the variation in the supraorbital region of the Middle Pleistocene fossils is less than that of a widespread Catarrhine species; and this variation does not indicate the existence of any subgroups that may be representative of separate taxa within this species. These results support the single, monotypic species classification of *Homo heidelbergensis s.l.* and the use of multiple, appropriate models of intra- and inter-group variation when studying biological variation in extinct hominin groups.

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### Differences in the non-masticatory dental wear of two medieval assemblages from the 4<sup>th</sup> cataract, Sudan

REBECCA J. WHITING<sup>1,2</sup>, SIMON HILLSON<sup>1</sup> and DANIEL ANTOINE<sup>2</sup>

<sup>1</sup>Institute of Archaeology, UCL, <sup>2</sup>Department of Ancient Egypt and Sudan, The British Museum

Previous research has demonstrated that examination of non-masticatory dental wear can deliver insight into past behavioural practices. Well preserved skeletons from two Medieval period sites in the 4<sup>th</sup> Cataract, Sudan have provided an opportunity to test this hypothesis. At site 3-J-18 enamel rim edge chipping increased with age, around 10% of adolescents, 30%/36% young/middle adult males and 21%/26% young/middle adult females showed ante-mortem chipping. The majority of the ante-mortem chipping was found in the molars, though a high prevalence of post-mortem chipping of the anterior teeth may have biased this result. 7% of individuals examined displayed polished grooves on the labial or buccal surfaces of either upper, lower or both dentitions. SEM analysis showed striations running almost invariably in a mesial-distal direction. Additionally two individuals were found to have interproximal grooves between the molars. The majority of labial and interproximal grooves were found in females. This data suggests that certain behaviour or cultural practices may have varied by sex. Preliminary results from 3-J-23, an earlier 4<sup>th</sup> cataract medieval site, are similar with regards to edge chipping but no labial or buccal grooves were observed. The cause of these groove patterns remains to be elucidated but, based on these two sites, appears to have been a feature of the late Medieval period. Further research on other sites and periods in the region will help contextualise these findings and add to our understanding of the inhabitants of the 4<sup>th</sup> cataract.

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### Mortuary Patterns and Health in New Kingdom Juvenile Burials from Tombos

KATIE M. WHITMORE<sup>1</sup>, MICHELE R. BUZON<sup>1</sup> and STUART T. SMITH<sup>2</sup>

<sup>1</sup>Department of Anthropology, Purdue University,

<sup>2</sup>Department of Anthropology, University of California, Santa Barbara

The site of Tombos is located in modern-day Sudan along the Third Cataract of the Nile River, and marked an important boundary between Nubian and Egyptian interaction during the colonial New Kingdom Period (c. 1400-1050 BC). During this time period, Egyptian and Egyptianized Nubian individuals were buried in the Tombos cemetery predominately using Egyptian mortuary practices, including monumental pyramid complexes and artifacts such as funerary cones,

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canopic jar heads, and *ushabti* figurines. In addition to Egyptian mortuary patterns, there are several notable examples of individuals interred using Nubian burial practices, a practice which continues into the postcolonial period. Previous bioarchaeological analysis of New Kingdom adult remains at Tombos exhibit low levels of skeletal markers of nutritional deficiencies, infection, traumatic injury, and strenuous physical activity. However, until recently very few juvenile individuals had been excavated at Tombos. Expanded excavation activities into the western portion of the cemetery have uncovered a number of juvenile individuals, suggesting that younger individuals were buried in particular locations within the cemetery. Examination of the mortuary patterns of juveniles provides insight how age identity was conceptualized by individuals at Tombos during this period of sociopolitical transition. In addition, the juvenile individuals reflect the relatively good health noted in adult individuals with very few instances of linear enamel hypoplasia, cribra orbitalia/porotic hyperostosis, osteoperiostitis, and traumatic injury.

### The link between social networks and gut microbial composition in black-and-white colobus (*Colobus vellerosus*)

EVA C. WIKBERG<sup>1</sup>, DIANA CHRISTIE<sup>2</sup>, FERNANDO A. CAMPOS<sup>3</sup>, PASCALE SICOTTE<sup>1</sup> and NELSON TING<sup>2</sup>  
<sup>1</sup>Anthropology and Archaeology, University of Calgary, <sup>2</sup>Anthropology; the Institute of Ecology and Evolution, University of Oregon, <sup>3</sup>Anthropology, Tulane University

The gut microbiome is associated with health and nutrition in humans and non-human primates. Although the taxonomic composition of the gut microbiome has been linked to group membership, it is not entirely clear whether this results from social contact or shared environments. We investigated social networks and diet as predictors of alpha (within-individual) and beta (between-individual) diversity of the gut microbiome in female *Colobus vellerosus* at Boabeng-Fiema, Ghana. We collected behavioral data using focal sampling of 22 adult females in 3 groups during 2008-2009. We also collected fecal DNA samples during a three-month period for subsequent 16S rRNA library preparation and sequencing on an Illumina NextSeq platform. We found no significant relationship between alpha diversity (i.e., Shannon-Wiener index) and centrality in the close proximity network (with similar structure as the grooming network) or dietary diversity (GLMM, all  $p > 0.05$ ). Beta diversity (i.e., Bray-Curtis dissimilarity) was not predicted by diet (permanova,  $p > 0.05$ ). Beta diversity was correlated with time spent in close proximity in one group (partial Mantel test controlling for relatedness,  $r = 0.61$ ,  $p = 0.01$ ), with females in frequent proximity having more similar gut microbiomes. Females in this population

either remain philopatric or disperse, which in turn affects social networks. This flexible social structure may influence the relationship between social networks and gut microbiomes beyond simple proximity patterns, and warrants further investigation. Our results highlight the need to investigate not only species-level but also group-level differences in how sociality shapes the microbiome, in particular in populations with flexible social structures.

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### Looking beyond Phalangeal Length and Curvature: Functional Correlation between Manual Phalangeal Articular and Collateral Ligamentous Morphology and Anthropoid Locomotor Adaptations

KATHLEEN M. WILES<sup>1</sup>, MATTHEW W. TOCHERI<sup>2,3</sup> and ANDREW S. DEANE<sup>4,5</sup>

<sup>1</sup>Kinesiology, University of Kentucky, <sup>2</sup>Anthropology, Lakehead University, <sup>3</sup>Human Origins Program, NMNH Smithsonian, <sup>4</sup>Anatomy and cell Biology, University of Indiana School of Medicine, <sup>5</sup>Evolutionary Studies Institute (ESI), University of Witwatersrand

Primates exhibit more diversity in locomotor behavior than any other mammalian order. Discrete locomotor adaptations are characterized by distinct patterns of phalangeal orientation with dissimilar patterns of mechanical loading. Phalangeal shaft length and curvature are frequently used to infer locomotion in fossil anthropoids given the direct and repetitive contact between the hand and substrate; however, most fossil anthropoid phalanges are fragmentary or incomplete. Given that articular epiphyses and associated collateral ligaments are subject to the same locomotor behaviour-specific mechanical loading that influences longitudinal shaft curvature and length, it is reasonable to predict that the proximal and distal articular surface morphology and collateral ligament fossae (CLF) are also influenced, at least in part, by locomotion.

We test the hypothesis that anthropoid phalangeal articular and collateral ligament fossae (CLF) morphology (i.e. contour curvature, size) varies with respect to locomotion and that more terrestrial primates experiencing higher compressive loads will have larger CLF's and increased mediolateral articular contour curvatures to resist mediolateral joint displacement. Segmented 3D models of proximal and distal articular surfaces and CLF's were obtained for the proximal phalanges (digits 2-5) of 16 locomotor diverse anthropoid genera ( $n=234$  individuals). Direct comparisons among individual taxa and locomotor groupings reveal that articular and CLF morphology is a composite function of size, phylogeny, and locomotion but that more terrestrial primates have greater mediolateral articular contour curvatures and larger, deeper CLF's

relative to more arboreal primates who have less mediolaterally restrictive joints with increased dorsoventral curvatures and smaller CLF's.

### Periodontal Disease and Periosteal Lesions in a Prehistoric Population from Kentucky: Searching for Evidence of Systemic Inflammation

KRYSTA N. WILHAM<sup>1</sup>, PHIL J. DIBLASI<sup>1</sup>, SHARON N. DEWITTE<sup>2</sup> and FABIAN A. CRESPO<sup>1</sup>

<sup>1</sup>Anthropology, University of Louisville, <sup>2</sup>Anthropology and Biology, University of South Carolina

Indian Knoll refers to an archaic population that existed between the late archaic and extending in the Woodland period along the Green River in Ohio County, Kentucky, USA. As one of the largest archaic collections in Kentucky, Indian Knoll has been the subject of a number of bioarchaeological studies, and serves as a reference population for our understanding of health and disease in the archaic period. In this study, we propose a new osteological analysis of the relationships among skeletal stress markers that are commonly associated with local inflammatory processes and that have the potential to be used as proxies for systemic inflammation. Specifically, the primary aim of this study is to examine the potential association of periodontal disease (PD) and periosteal lesions (PL). The presence and severity of these osteological lesions in 234 individuals were scored, and the association between PD and PL was evaluated using Chi-square analysis. Our analysis reveals a positive association between PD and PL, suggesting a potential underlying hyper-inflammatory status or phenotype. These findings may indicate that different stress factors could have induced a shift in systemic inflammation. However, positive associations were also observed between PD and age, and PL and age, which might indicate an age effect. We propose to expand the analysis to other bone markers such as cribra orbitalia and porotic hyperostosis, and include a comparative analysis with other populations that share a similar timeline or environmental context, to produce a more comprehensive understanding of the stress markers analyzed.

### Interannual variation in *Ptilocolobus badius badius* diet in Cote d'Ivoire's Tai National Park: implications for conservation

M. ALEXANDRA WILKINS, W. SCOTT MCGRAW and ERIN E. KANE

Anthropology, The Ohio State University

Long term data indicate that several species of East African red colobus (*Ptilocolobus tephrosceles*, *Ptilocolobus rufomitratus*, and *Ptilocolobus kirkii*) display significant inter and intra annual dietary variation. Much less is known about the extent of variation in the diets of West African red colobus. This study examines long term feeding

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data from one group of Western red colobus, *P. badius badius* ranging in Cote d'Ivoire's Tai Forest and tests the hypothesis that decreased rainfall leading to reduced fruit production have resulted in significant changes in consumption of several key food items including *Scytopetalum tiegemii*, *Lophira alata*, and *Dialium aubrevillei*. Feeding profiles consisting of average annual contribution of individual plant species from three periods (1996, 1997, 2015) were compiled from hourly food scans of all visible individuals. Kruskal-Wallis and Spearman's tests were used to test for differences between periods and to identify correlations between tree abundance and food preference. Results show no significant difference in percent contribution to overall diet among only those species consumed across all three periods ( $p=0.482$ ); however, the total number of plant species consumed decreased significantly over time. Moreover, no correlation exists between tree abundance and percent contribution to diet ( $p=0.224$ ). These results highlight that food selection by Tai red colobus is not determined solely by food availability, nor is the *P. badius badius* diet intractable. Identifying those elements of the red colobus diet that are vital, especially given the influence of climate change on forest production, is necessary for safeguarding all red colobus populations across Africa.

### Trauma Prevalence among Enslaved African Males and Females between the 17<sup>th</sup> and 19<sup>th</sup> Centuries in the United States

KORTNEY WILLIAMS

Anthropology, Binghamton University

Violence against enslaved Africans has been long discussed, especially the acts that occurred in the United States during the antebellum period. Scholars have debated over who experienced more violence: enslaved African males or females. This study contributes to that debate by examining the skeletal remains of enslaved Africans in the United States between the 17<sup>th</sup> and 19<sup>th</sup> centuries. The focus of this research project is to determine if there is a difference in trauma based on sex and if there is a pattern in the location of trauma by sex. In order to execute this research, data were collected from a sample of 36 individuals from three cemeteries curated at the Physical Anthropology Division of the Smithsonian Institution's National Museum of Natural History: the Catocin Furnace, Cliffs Plantation, and Deep River. Additionally, data from approximately 250 individuals from the African Burial Ground database were used to complete the sample. The skeletal remains were macroscopically examined for the presence of trauma. While enslaved African males experienced more trauma than females, chi-square analysis revealed this was not a significant difference ( $p=0.124$ ). Multiple individuals exhibited more than one traumatic insult. These results are

discussed in the context of injuries being related to work versus interpersonal violence enslaved Africans faced due to the cultural norm of being inferior to Europeans during slavery.

### Combining Multiple Osteological Recording Standards in a Single Database: Applications for International Research

LESLIE LEA WILLIAMS

Anthropology, Beloit College

Bioarchaeology is an international discipline in both the scope of its research and the nationalities of its researchers. Bioarchaeologists must often choose which data collection standards they will use in their research or develop ways to combine those standards. In my research, this means melding Buikstra and Ubelaker's (1994) standards with those from international research projects such as the Global History of Health Project and from local research institutions with their own standards. Non-digital methods of data collection and spreadsheet programs like Excel, while flexible, are prone to errors and are not designed for long term data storage.

This paper discusses how a relational database, created in Filemaker Pro or Microsoft Access, is a digital solution to these challenges, allowing researchers to easily enter data using multiple standards or convert from one standard to another. These data transformations, coded into the database itself, streamline the process from data collection to data entry to data analysis. In particular, variable definitions can be built into the structure of the database itself, ensuring that user created variables are understandable to multiple researchers. Likewise, the association of digital images and pdf files with specific skeletal records can allow for replicability of studies in the face of reburial or other situations where access to skeletal remains is lost. Given the sheer number of data points collected by osteologists from each individual, indeed from each bone, well-designed databases can ensure digital data are accurate, clearly organized, and properly curated.

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### Trait Variation, Convergence, and Ecogeographic Patterns in *Macaca* Crania

SAMUEL J. WILLIAMS and BENJAMIN M.

AUERBACH

Anthropology, University of Tennessee, Knoxville

Morphological variation among *Macaca* species exhibit ecogeographic patterns thought to reflect responses to natural selection. Species from different clades of macaques independently evolved similar morphologies, presumably due to selection pressures associated with climate. *M. radiata* and *M. fascicularis* display cranial traits determined previously to have evolved

due to directional selection. Species within the clades to which they belong, the Sinica group and the Fascicularis group, have larger bodies in colder climates, which is paralleled in craniofacial morphology. It is unknown whether these morphological similarities are convergent, and thus driven by selection toward a similar adaptive peak, or if the species have arrived at similar morphologies by chance (i.e., through neutral evolutionary processes).

In this study, we use a modified Ornstein-Uhlenbeck framework to examine whether craniofacial variation among macaque species is better explained by convergence or chance. This method models multiple optima across all branches of a phylogeny simultaneously, allowing for a best fit model to be calculated without a priori assumptions of where the optima should lie. We use six craniofacial inter-landmark distances collected from ten macaque species representing the four main groups described by Li et al. (2009. *Gene* 448:242-249). *Phamadryas* and *T. gelada* were included in the analysis as outgroups. Our results did not support convergence between *M. radiata*, *M. fascicularis*. However, there is support for convergence between *M. sylvanus* and *M. thibetana*, where facial height and inter-orbital breadth appear to have responded to non-neutral evolutionary forces. We further examine measures of selection and evolvability to ascertain evolutionary contributions from individual traits.

### Total numbers of vertebrae clarify the ancestral vertebral formula of African apes and humans

SCOTT A. WILLIAMS<sup>1,2</sup> and DAVID PILBEAM<sup>3</sup>

<sup>1</sup>Center for the Study of Human Origins, Department of Anthropology, New York University, <sup>2</sup>New York Consortium in Evolutionary Primatology, <sup>3</sup>Department of Human Evolutionary Biology, Harvard University

Numbers of precaudal vertebrae are relatively stable in mammals, with cervical vertebrae fixed at seven in nearly all species, 19-20 thoracolumbar vertebrae (TL), and 29-30 precaudal vertebrae (PC), whereas the number of tail vertebrae is highly variable both within and between major clades. Hominoid primates have varying short trunks, generally between 16 (orangutans, eastern gorillas) and 18 (hylobatids) TL, 28-31 PC, and 1-5 coccygeal vertebrae (Co); they lack external tails. Researchers have focused mostly on numbers of PC and the observation that chimpanzees and especially bonobos (panins) possess more PC vertebrae than humans and other hominoids. More appropriately, if Co are included to yield a total vertebra count, humans and panins possess similar numbers of total vertebrae (TV=33). This is because humans tend to possess one less sacral segment and one more Co than panins. When combined, humans

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and panins possess 17 TL and 9 sacrocaudal vertebrae (SC). Together, the evidence from TV is best interpreted in a homeotic framework, which reflects the expression boundaries of underlying Hox genes. Hox10 expression boundaries correspond with the TL and SC borders; thus, a cranial shift of Hox10 expression in an ancestor with a chimpanzee- or bonobo-like vertebral formula (7C:13T:4L:6S:3Co; TV=33) would result in homeotic changes at the TL and SC boundaries while maintaining the integrity of the lumbosacral boundary (and TL number), resulting in a human-like vertebral formula (7C:12T:5L:5S:4Co; TV=33). This evolutionary scenario involves neither the extensive homoplasy in extant apes nor reversals in human evolution proposed by some researchers.

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### Engaging Undergraduate Students in Research

SLOAN R. WILLIAMS

Anthropology, University of Illinois at Chicago

Engaging with undergraduate students outside the classroom introduces them to your own field in a more hands on way, whether in the field, lab or elsewhere. If students are considering graduate school, research experience is a must. More generally, research experience fosters creativity and independence and enables students to develop relationships with faculty who can write strong letters of support. Studies have shown that these types of collaborative projects improve retention, performance, and graduation rates, especially for underrepresented and at-risk students. Consequently, research funding is often available at the departmental, college and university levels to cover research expenses and provide student financial support. National funding agencies also provide mechanisms for including undergraduate students in both individual and training grants. Nonprofit organizations bring students and faculty together as well, especially in the STEMs (science, technology, engineering and mathematics). This presentation will summarize some of the resources available to faculty and highlight some of the ways in which biological anthropologists can engage undergraduate students in their work. Undergraduate students who participate in research gain firsthand experience and become more critical consumers of research, ideally resulting in a public more likely to be supportive of academic research.

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### The biomechanics of stone tool behaviors and implications for the evolution of the human hand

ERIN MARIE WILLIAMS-HATALA<sup>1,2</sup>, KEVIN G. HATALA<sup>1,2</sup>, MCKENZIE GORDON<sup>1</sup>, MARGARET KASPER<sup>1</sup> and TRACY L. KIVELL<sup>3,4</sup>

<sup>1</sup>Biology, Chatham University, <sup>2</sup>Center for the Advanced Study of Human Paleobiology, The George

Washington University, <sup>3</sup>Animal Postcranial Evolution Lab, Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent, <sup>4</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology

It is widely agreed that the biomechanical stresses resulting from stone tool behaviors influenced the evolution of the human hand. However, archaeological evidence suggests early hominins participated in a variety of stone tool behaviors, and it is unlikely that all of these behaviors equally influenced our hand anatomy. Instead, a behavior's likelihood of exerting a selective pressure is a function of the magnitude of stresses associated with that behavior and the amount of time spent performing it. The latter may be impossible to infer but here we address the former, investigating two specific questions: 1) do individuals conform to a consistent manual pressure distribution during all stone tool behaviors and 2) if not, which behavior imposes the greatest biomechanical stress?

Manual pressure data were gathered from 39 subjects using a Novel manual pressure system while they participated in ten different Paleolithic tool behaviors. Tested behaviors included nut cracking, marrow acquisition, flake production, and handaxe and flake use. Manual pressure distributions varied significantly according to behavior ( $p < 0.001$ ; MANOVA with Pillai-Bartlett), though there was a tendency for regions of the hand subject to the lowest pressures (e.g., proximal phalanges) to experience smaller effect sizes. Marrow acquisition and flake production consistently placed the greatest loads on the hand as a whole, on each digit and on each phalanx. These results suggest that marrow acquisition and flake production are the most likely of the assessed behaviors to have influenced our hand's anatomical and functional evolution.

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### Biological and Cultural Factors influencing Non-masticatory Dental Wear in Early and Late Upper Paleolithic Humans

JOHN C. WILLMAN<sup>1</sup> and KRISTIN L. KRUEGER<sup>2</sup>

<sup>1</sup>Anthropology, Washington University in St. Louis,

<sup>2</sup>Anthropology, Loyola University Chicago

Research on non-masticatory dental wear related to the use of the "teeth-as-tools" among Late Pleistocene humans is historically biased toward descriptions of Neandertals. As a result, little is known about non-masticatory behaviors among Early (~40-20,000 BP – "EUP") and Late (~19-10,000 BP – "LUP") Upper Paleolithic modern humans. Here we address this gap using

a combination of macroscopic and microscopic methodologies.

Results show a typical hunter-gatherer pattern of high anterior relative to posterior macrowear gradients among both EUP and LUP samples. However, when wear gradients are scaled to buccolingual crown dimensions, the variability in the LUP sample is much greater despite substantial overlap between samples. Instrumental striations ("cutmarks" on labial enamel related to "stuff-and-cut" behaviors) on maxillary central incisors were found on 100% of teeth analyzed (EUP=16 and LUP=2). Enamel chipping was present on 25% of EUP (N=24) and 60% of LUP (N=10) maxillary central incisors, but the difference is not significant. Lastly, dental microwear texture analysis (DMTA) showed no significant differences between anisotropy or textural fill volume (variables sensitive to distinguishing between dietary and non-dietary tooth-use) between the EUP or LUP samples. However, anisotropy is relatively low and textural fill volume is relatively high in both groups – a combination that relates to some clamping and grasping behaviors (e.g. in hide preparation) in bioarchaeological groups.

In sum, these results indicate that Upper Paleolithic humans engaged in substantial anterior tooth-use for non-masticatory, manipulative behaviors. The patterning of behaviors by climate and habitat will be explored in future analyses.

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### Digitised Diseases and Data Structure: Challenges and Future Directions

JO BUCKBERRY, TOM SPARROW, ANDREW D. HOLLAND, REBECCA A. STORM, KEITH MANCHESTER, EMMA L. BROWN, CHRIS GAFFNEY and ANDREW S. WILSON

School of Archaeological Sciences, University of Bradford

Digitised Diseases was developed as a major educational and research tool focused on chronic pathological conditions affecting the skeleton. The project was a major collaboration between the University of Bradford, The Royal College of Surgeons (London), Museum of London Archaeology, the Museum of London and other project partners that began in 2011. From inception it was apparent that considerable effort was required to structure both the day-to-day data handling and to define the categories that would be used in specimen selection and web hosting of the resource. The range of data capture and post-processing tasks that needed to be tracked between teams working in London and in the Biological Anthropology Research Centre and Centre for Visual Computing at Bradford involved 3D laser scanning, texture photography,

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hole-filling, UV mapping and texturing alongside specimen descriptions and clinical synopses. Specimen selection and description required early attention to create a structural hierarchy that would have the widest possible practical usage and understanding across a range of disciplines including palaeopathology, biological anthropology, bioarchaeology, as well as with clinicians and in the medical humanities, whilst recognising that many of the extant disease classifications in medicine were less well suited to cases from archaeology and medical history. The resulting hierarchy and disease classification has gone through many iterations. Each pathological abnormality is assigned to a main disease class and sub-class, with a series of sub-classes for infective and neoplastic disease. The hierarchy continues to be reviewed as we look to include more cases into the future.

*The authors would like to thank the University of Bradford and Jisc for funding Digitised Diseases*

### **The Development of the Mid-Continental U.S. Vacant Quarter: The Impact of Aggregation, Warfare and Climate Change on Late Pre-Columbian Population Dynamics**

JEREMY J. WILSON

Anthropology, Indiana University-Purdue University Indianapolis

The Vacant Quarter is an area of mid-continental North America largely abandoned by Native peoples formerly living in large, often fortified settlements supported by agriculture between 900 and 500 years ago. Hypothesized drivers of this depopulation include infectious diseases, socio-political instability, warfare, and the Little Ice Age's onset. In conjunction with ongoing hydroclimate research reconstructing mid-continental pluvial and drought episodes, the current research examines mortality and warfare-related trauma among Fort Ancient communities of the Ohio River Valley. Contrary to their Mississippian contemporaries, settlement patterns suggest an aggregation from smaller, outlying villages into larger communities along the Ohio River by AD 1400 with temporal persistence beyond the abandonment of most Mississippian villages.

To reconstruct population dynamics among Fort Ancient communities, Transition Analysis and parametric hazard models were utilized to develop optimized survival curves comparing the age- and sex-specific risk-of-death for 1,644 individuals from six Fort Ancient settlements spanning in age from 1,000 to 400 years ago. Hazard modeling indicates a less severe age-specific risk-of-death among Fort Ancient populations with a smaller proportion of reproductive-age females dying in comparison to Mississippian populations living in larger and denser villages. Meanwhile, perimortem, warfare-related trauma fluctuates

from a peak of 7% among all adults in early Fort Ancient times to a mostly male phenomenon around 8% after AD 1400. These results suggest a population history and trajectory different from observed Mississippian groups, enabling some Fort Ancient communities to overcome a period of novel disease ecology, endemic warfare and drought that engulfed much of the mid-continent.

### **Geometric morphometric analysis of variation in human hallucal metatarsal periosteal and endosteal shape in rural and urban populations**

LAURA A.B. WILSON<sup>1</sup>, ISABELLE DE GROOTE<sup>2</sup> and LOUISE T. HUMPHREY<sup>3</sup>

<sup>1</sup>School of Biological, Earth and Environmental Sciences, UNSW, Sydney, <sup>2</sup>School of Natural Sciences and Psychology, Liverpool John Moores University, <sup>3</sup>Department of Earth Sciences, The Natural History Museum, London

Structural variability in long bone diaphyses has been linked to habitual behaviors and mobility patterns, reflecting the morphological response of bone to mechanical strain associated with activity. The diaphysis of the hallucal metatarsal reflects load history during the stance phase of a bipedal gait, and variation in substrate use and footwear can induce a plastic response of the forefoot bones. Here, periosteal and endosteal shape of hallucal metatarsal cross-sections were quantified using geometric morphometrics. We a) evaluate sex- and age-related shape variation in endosteal and periosteal contours, b) quantify shape differences in urban and rural shod individuals, and c) compare patterns of shape variation with traditional measures of biomechanical performance. CT scanned metatarsals from Spitalfields London (urban) and Abingdon (rural) groups (N=74) were analyzed. Sixteen landmarks at equiangular radii were automatically placed on periosteal and endosteal outlines, extracted from cross-sections at bone midlength. For both groups, Procrustes ANOVAs indicated a significant effect of age on endosteal shape, but not on periosteal shape. Age-related shape changes in endosteal shape were correlated with cortical area measurements and reflected the addition of bone mass to the endosteal surface with age in both sexes. Older individuals differed in shape exclusively along the anterior-lateral margin of the endosteal outline. Comparisons between sample revealed no significant shape differences but Spitalfields showed significantly greater disparity in periosteal shape. Patterns of periosteal shape variation on PC2 are correlated with values for bending strength along the anterior-posterior plane.

*This research is supported by the Australian Research Council Discovery Program (DE150100862 granted to LABW), and the Calvea Foundation.*

### **High-stakes Fighting: Monopolizability of Females Promotes Intragroup Killing in Chimpanzees**

MICHAEL L. WILSON<sup>1,2</sup>, EMILY E. WROBLEWSKI<sup>3</sup>, NICOLE M. SIMMONS<sup>4</sup>, DEUS C. MJJUNGU<sup>5</sup>, SHADRACK M. KAMENYA<sup>5</sup>, REBECCA S. RUDICELL<sup>6</sup>, BEATRICE H. HAHN<sup>7,8</sup> and ANNE E. PUSEY<sup>9</sup>

<sup>1</sup>Anthropology, University of Minnesota, <sup>2</sup>Ecology, Evolution and Behavior, University of Minnesota, <sup>3</sup>Structural Biology, Stanford University School of Medicine, <sup>4</sup>Zoology, Makerere University, <sup>5</sup>Gombe Stream Research Centre, the Jane Goodall Institute, <sup>6</sup>Vaccine Research Center, National Institutes of Health, <sup>7</sup>Medicine, Perelman School of Medicine, University of Pennsylvania, <sup>8</sup>Microbiology, Perelman School of Medicine, University of Pennsylvania, <sup>9</sup>Evolutionary Anthropology, Duke University

While male chimpanzees are well known for aggressive, sometimes lethal, intergroup interactions, they also sometimes kill grown males from their own community. Such intragroup killings are puzzling, given the importance of numerical strength for winning intergroup contests. Based on evidence from Gombe National Park, Tanzania and Kyambura Gorge, Uganda, we propose that intragroup killings result from reproductive competition, which becomes particularly intense when demographic factors enable the alpha male to monopolize access to fertile females. We examined data from Kyambura (2006-2009; median = 3 males, 6 females  $\geq$  12 years old) and two communities at Gombe (1997-2015): Mitumba (3 males, 8 females) and Kasekela (12 males, 19 females). Days on which multiple parous females were observed mating (and thus less easily monopolized by a single male) occurred more frequently in the larger Kasekela community (median = 10% of days) than in the smaller Mitumba and Kyambura communities (1.9% and 1.5% of days, respectively). As a consequence, the reigning alpha male obtained only 30.3% of 33 known paternities in Kasekela, but obtained 78.6% of 14 known paternities in Mitumba, and likely sired both infants born in Kyambura. Corresponding to this variation in reproductive skew, intragroup killings occurred in Kyambura (n = 1) and Mitumba (n = 2-5) but not Kasekela. Our evidence thus indicates that variation in the monopolizability of fertile females can profoundly affect the intensity of male reproductive competition. Nonetheless, the occurrence of intragroup killings in larger communities (e.g., Ngogo) indicates that additional factors also need to be considered.

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## ABSTRACTS

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### Determination of Season at Death Using Dental Cementum Increment Analysis to Assist in the Identification Process of Unaccounted-for US Service Members from Past Conflicts

NICHOLAS D. WILSON<sup>2,3</sup>, KATRIN KOEL-ABT<sup>1</sup> and KRISTINA N. SCHMIDT<sup>1,4</sup>

<sup>1</sup>DPAA Laboratory, <sup>2</sup>Hawaii AEGD 2-Year Residency, U.S. Army Dental Corps, <sup>3</sup>Uniformed Services University, <sup>4</sup>Department of Anthropology, University of Hawaii

There are few published research studies on the use of dental cementum to determine the season at death in humans. With increased development of a standardized technique it may play an important role in forensic identifications and identifying some of the 83,000 unaccounted-for US Service Members. The mission of the Defense POW/MIA Accounting Agency's laboratory is to search for, recover, and identify U.S. personnel missing from past military conflicts, and therefore it is imperative to develop a standardized method which accurately determines the season at death especially for ground losses (e.g. battle fields). This technique is based on cementum deposition of alternating layers of dark and light. One band of light/dark represents one year that has been divided into seasons, with the outer layer representing the season of death. The present study utilizes the analysis of tooth cementum annulations in the blind to determine the season at death of 50 teeth with known date of extraction of current male and female US Service Members, ranging from 18-50 years old. Three sections of each tooth were evaluated with a light microscope and polarizing lenses by three different observers in the blind. A high interobserver agreement was found along with an accurate correlation of cementum ring type and season. The relation of cementum ring and season was even present in individuals whom have lived in multiple different climates throughout their lives. It is concluded that there is an accurate correlation between cementum ring annulations and season in humans.

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### Climate Change and Enamel Defects: Interpreting the Childhood Stress of Early Levantine Agriculturalists

TERESA V. WILSON

Department of Geography and Anthropology, Louisiana State University

Searching for the physiological effects of climate change in cemeteries with no historical record requires extensive climate data. This study examined five populations of Levantine agriculturalists from Jordan for evidence of childhood stress in the form of enamel defects. The expectations

in this region are that wetter climates should produce more crops and drier climates should have a negative impact on nutrition-related stress due to decreased crop yields. There is a clear shift in the study region from a warmer and drier average climate in the Bronze Age (beginning around 2,000BCE) to a wetter and cooler average climate in the Byzantine era (ending around 640CE).

Canine teeth (n=324) from five sites spanning from the Middle Bronze Age to the Byzantine era were collected, thin sectioned, and analyzed to determine the mean number of linear enamel hypoplasias (LEHs) and accentuated striae of Retzius (Wilson bands). The lowest average LEHs per person came from the Byzantine era (0.67), however the differences in LEHs is not statistically significant ( $p < 0.1676$ ) across the time periods. There were higher averages of per individual Wilson bands in the Byzantine (6.38) versus the Bronze Age (4.27). The Bronze Age had significantly higher numbers of LEHs ( $t=2.18$ ,  $p < 0.01$ ), while Wilson bands were higher in the Byzantine era ( $t=3.01$ ,  $p < 0.001$ ). This analysis shows that climate may not have contributed to the formation of the enamel defects and there is no evidence of childhood physiological stress due to climate change at these sites.

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### Effects of Age, Activity, and Obesity on Osteoarthritis in a Modern European-American Skeletal Sample

ALLYSHA P. WINBURN

Anthropology, University of New Hampshire, Anthropology, University of Florida

Skeletal articular degeneration (osteoarthritis or OA) affects current and past human populations. While long studied, its multifactorial etiology remains incompletely understood. Forensic anthropologists tend to emphasize its general tendency to increase with age; bioarchaeologists often assert a correlation with physical activity. Medical researchers posit a relationship with obesity.

This study investigates the effects of age, habitual activities, and obesity (via body mass index [BMI]) on OA in a modern U.S. skeletal sample (W.M. Bass Collection, Tennessee). Major appendicular joint surfaces of 198 female and 210 male European-Americans (19-101 years) were examined and scored for OA presence/severity. Chi-squared and Wilcoxon rank-sum tests ( $\pm 0.05$ ) explored relationships between observed OA and documented ages, habitual physical activities, and BMI.

While females and males exhibited different OA patterning, both sexes exhibited the highest levels of OA in the hips. In most joints, OA correlated

positively with age (both sexes). However, OA correlated positively with BMI category only in the left temporomandibular joint (females) and knees (both sexes). Further, OA correlated negatively with activity in the female left shoulder and right knee and positively in the male left knee and right ankle.

This research demonstrates that the etiology of OA is indeed multifactorial and joint-dependent. Age appears to contribute more to OA than activity or obesity, except in the knees. In contrast, while subject to high levels of OA, the hips appear relatively resistant to the effects of obesity and activity, possibly due to their anatomically protected position – highlighting their potential as anthropological age indicators.

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### Sex-Related Differences in Dental Caries Prevalence in the Prehistoric American Southwest

ROBIN T. WINEINGER

Anthropology, New Mexico State University

Dental remains provide valuable insight into the health status of past populations. This research comprises an in-depth study of the oral health from three Prehistoric Southwest sites in order to identify sexual differences in the prevalence of dental disease after the onset of agriculture. Dental pathologies, such as dental caries and antemortem tooth loss (AMTL), directly relate to an individual's diet, therefore indicate disparities in subsistence and dietary patterns.

Previous studies have found that females exhibit a higher rate of caries when compared to that of males. These differences are considered to be the result of physiological, behavioral, or social variances between or within communities. Therefore it is important to not only infer whether these populations had differences between the sexes but also the causes of these disparities. My research aims to reveal further insight into regional and temporal perspectives among pueblo skeletal samples.

Specimens from the Southwestern sites of Pottery Mound (LA416), NAN Ranch ruins (LA2465) and Kuaua Pueblo (LA187) were used for this research. I examined 57 male and 56 female dentitions to uncover possible sex-related disparities in dental caries. The males and females from Pottery Mound and Kuaua pueblos exhibited similar rates of dental caries and AMTL, suggesting that there was no distinct variation in dietary patterns or behaviors between the sexes. NAN Ranch held the most statistically significant differences between males and females, indicating that the factors associated with the

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development of dental pathologies are complex and ultimately depend on site-specific dynamics.

### Using Mitogenomes to Understand Dog Population History in the Americas

KELSEY E. WITT<sup>1</sup> and RIPAN S. MALHI<sup>2,3</sup>

<sup>1</sup>School of Integrative Biology, University of Illinois at Urbana-Champaign, <sup>2</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>3</sup>Carl R. Woese Institute for Genomic Biology, University of Illinois at Urbana-Champaign

The domestic dog spread across the Americas not long after humans migrated to the continent, and it has been an important part of the lives of many Native American groups for thousands of years. However, the timing and routes of their expansion are largely unknown, and most published sequences of ancient dogs in the Americas are limited to the control region of mitochondrial DNA. Clarifying dog population history can provide insight into the histories of the human populations that traveled with them. We sequenced the mitogenomes of over 50 dogs from the Midwest, Southwest, Pacific Coast, and Southeast, ranging in age from 1000 to over 6000 years old, and compared to the three published mitogenome sequences of dogs in the Americas to assess how dog genetic diversity has changed over time and space. We find that sequencing the complete mitochondrial genome provides a higher-resolution view of dog population history, and that dogs with the same control region haplotype can have mitogenome haplotypes that differ by as many as 20 substitutions. Dog population genetic diversity varies within a geographic region, which suggests that selective breeding was practiced in some regions. Additionally, shared mitochondrial lineages between Ohio Hopewell and Illinois Late Woodland dogs suggest a recent shared ancestry for these populations, as well as the possibility of human interactions between these regions. We also modeled dog demographic history over time, to show how the dog population as a whole in the Americas has changed in size.

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### Inter-tooth differences in enamel defect and $\delta^{18}\text{O}$ sequences: implications for research on individual high resolution stress histories

CARSTEN WITZEL<sup>1</sup>, ARKADIUSZ SOLTYSIAK<sup>2</sup>, EWA KRZEMIŃSKA<sup>3</sup> and ZBIGNIEW CZUPYT<sup>3</sup>

<sup>1</sup>Biology, University of Hildesheim, <sup>2</sup>Bioarchaeology, University of Warsaw, <sup>3</sup>Micro-area Analysis Laboratory, Polish Geological Institute - National Research Institute

Incremental markings in dental enamel (prism cross striations, PCS and Striae of Retzius, SR) reflect regular fluctuations in the secretory stage of amelogenesis. This enables reconstruction

of high-resolution chronologies of hypoplastic enamel defects. More recently, approaches using differential isotope content at different levels of spatial resolution have been developed to reconstruct the living conditions during childhood.

We used 4 permanent teeth from two individuals representing different archeological sites in Northern Syria to combine both approaches. Serial measurements of oxygen isotopic values ( $\delta^{18}\text{O}$ , VSMOW) using sensitive high-resolution ion microprobe (SHRIMP IIe/MC) were performed along the enamel dentin junction (EDJ) in axiobuccolingual sections (spot size c. 25  $\mu$ ). Chronologies of tooth formation were reconstructed in thin sections based on PCS spacing and measurements of segments of enamel prisms close to the EDJ by light microscopy.

An upper and lower permanent canine found isolated exhibited closely matching sequences and timing of major accentuated SR (max. difference 11 days) making the origin from the same individual highly likely. Sequence similarities between a permanent first molar and canine, belonging to the other individual, also revealed good accordance. In contrast values of  $\delta^{18}\text{O}$  in the overlapping phases of formation chronology showed a higher variation (14 – 22 ‰) and a significantly poorer alignment.

Combination of these methods offers great potential for reconstructing individual high-resolution stress histories. But the fact that they refer to slightly different time scales, in that incremental analysis reflects enamel secretion and isotopic analysis includes also enamel maturation has to be further elucidated.

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### Long-term spatial memory in *Eulemurs* and effects of learning schedules

RACHELLE WOLK

Department of Basic Sciences, New York University College of Dentistry

We examined long-term memory in *Eulemurs* and the impact of distributed learning schedules on their ability to recall the location of food sources. Recent experimental work indicated that *Eulemurs* could not recall the location of a single baited site after 12 massed exposures and a 1-week delay. We conducted our study at the Lemur Conservation Foundation in Florida. Our analysis focused on 1) determining if the *Eulemurs* demonstrated memory, and 2) if learning schedules produced a significant difference in retention. We tested two distributed schedules that differed in the spacing of the first five trials (Learning Trials): one included 1-2 hour delays and the other included 1-day delays. We placed containers, 1/3 baited, in consistent locations. A sniff of a container was considered as

a visit. A two-way split plot ANOVA showed no significant difference between distributed schedules. A t-test analysis of container visits was not significant for the Learning Trials, but supported the memory hypothesis for delays of 1, 2, 4, 7, and 14 days. Their visits indicated an achievement of 2/3 of perfect scores. The *Eulemurs* opened 100% of baited containers and 11% of empty containers, indicating that they relied on olfaction at close range. These experiments 1) demonstrate the first time a lemur species has shown evidence of spatial memory for multiple locations for a one-week delay, 2) shows the effectiveness of a distributed over a massed schedule for long-term memory and 3) indicates that lemurs rely on memory and olfaction to locate food.

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### Menopause is Common among Wild Female Chimpanzees in the Ngogo Community

BRIAN M. WOOD<sup>1</sup>, KEVIN E. LANGERGRABER<sup>2</sup>, JOHN C. MITANI<sup>3</sup> and DAVID P. WATTS<sup>4</sup>

<sup>1</sup>Anthropology, Yale University, <sup>2</sup>School of Human Evolution and Social Change, Arizona State University, <sup>3</sup>Anthropology, University of Michigan, <sup>4</sup>Anthropology, Yale University

A previous analysis of fertility in six communities of wild chimpanzees (Emery Thompson et al. 2007) reported that female fertility declined in parallel with declining survivorship. The authors reported no births for females aged 50 or older and no females survived past age 55. They concluded that menopause was not a normal feature of chimpanzee life history in the wild. However, data were not yet available from Ngogo, where the unusually large chimpanzee community experiences favorable foraging ecology, low levels of anthropogenic disturbance, and a history of success in between group competition. Here, we report Ngogo female fertility and survivorship across the life course. Age specific fertility rates do not markedly differ from those in other chimpanzee communities. The median interbirth interval after the birth of a surviving offspring was 63.5 months (n=72, SE=1.7), shorter than the median value of 68.9 months (n=288, SE=1.2) in other communities reported by Emery Thompson et al. Consistent with prior reports, no Ngogo females aged 50 and older were known to give birth (max age=49). However, female survivorship commonly extended well beyond the fertile period. Life table calculations show that 41% of Ngogo females are expected to survive to age 50; those who do can expect to survive an additional 9 years. At least six females have survived 10 years or more after the births of their last offspring. Post-fertile female survivorship at Ngogo appears to arise as an epiphenomenon

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of lowered mortality rates across the life-course, ascribable to Ngogo's favorable ecology.

L.S.B. Leakey Foundation, National Geographic Society, US National Science Foundation, Yale University, University of Michigan, Boston University, MPI for Evolutionary Anthropology, Arizona State University.

### Posttraumatic stress and psychological resilience in Nepali child soldiers: an interdisciplinary study in human social genomics

CAROL M. WORTHMAN<sup>1</sup>, BRANDON A. KOHRT<sup>2</sup> and STEVEN W. COLE<sup>3</sup>

<sup>1</sup>Anthropology, Emory University, <sup>2</sup>Duke Global Health Institute, Duke University, <sup>3</sup>Department of Medicine, School of Medicine, UCLA

Research on the enduring effects of early adversity has yielded powerful insights into pathways by which culture gets under the skin and illuminated the roots of health disparities. Transformative collaborations among biomedical and social sciences have fueled these advances by flexibly combining heretofore dispersed sets of theory, expertise, and methods. In the case reported here, three social scientists (psychology, cultural and biological anthropology) with strong biomedical roots (immunology, psychiatry, human biology) were united by common interest in the social ecology of health to examine the effects of trauma in 254 former child soldiers and matched non-combatant civilians. Deployment of innovative functional genomics techniques to characterize exposure to hardship via the conserved transcriptional response to adversity (CTRA) offered a window onto factors determining post-trauma recovery, while novel application of the CTRA in a non-western, longitudinal sample offered a chance to test predictions from immune ecology and life history. We found apparent conservation of the CTRA in this setting: former child soldiers exhibited up-regulated CTRA gene expression. However, activation increased in direct relation to post-traumatic stress (PTSD) severity rather than as a function of child soldier status itself. Perceived psychological resilience markedly buffered CTRA activation to the extent that activation levels in PTSD-affected former child soldiers reporting high resilience were comparable to those in PTSD-free civilians.

These findings address questions about the nature of resilience and advance our knowledge concerning mental health treatment of trauma survivors, stress physiology, and immune ecology and adaptation, while demonstrating the value of interdisciplinary research.

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### Archaic hominin introgression in Africa contributes to functional salivary *MUC7* genetic variation

DUO XU<sup>1</sup>, PAVLOS PAVLIDIS<sup>2</sup>, NIKOS ALACHIOTIS<sup>2</sup>, COLIN FLANAGAN<sup>1</sup>, RAN BLEKHMANN<sup>4</sup>, STEFAN RUHL<sup>3</sup> and OMER GOKCUMEN<sup>1</sup>

<sup>1</sup>Biological Sciences, SUNY Buffalo, <sup>2</sup>Institute of Molecular Biology and biotechnology (IMBB), Foundation of Research and Technology–Hellas, <sup>3</sup>Dental Medicine, SUNY Buffalo, <sup>4</sup>Department of Genetics, Cell Biology, and Development, University of Minnesota

One of the most abundant proteins in human saliva, mucin-7, is encoded by the *MUC7* gene. In last year's AAPA meetings, we presented the adaptive evolution of copy number variation of subexonic PTS-repeats within *MUC7* among primates. Here, we present several lines of evidence suggesting that PTS-repeat copy number variation has evolved through at least 2 recurrent events in the human lineage, generating multiple haplotypic backgrounds carrying 5 or 6 PTS-repeat copy number alleles. Population genetics analyses suggest that one of the recurrent haplotypes carrying a 5 PTS-repeat copy is an unusually divergent sub-Saharan African lineage. Using simulation-based analyses, we now verified recent observations that an introgression event from an archaic African hominin best explains haplotypic variation in a small, but observable number of loci in sub-Saharan Africans. Then, we were able to cluster *MUC7* with 93% confidence among loci where signatures of introgression were observed. Based on these, we conclude that some of the *MUC7* haplotypic variation originated in an unknown African hominin population and introgressed into ancestors of modern Africans. In addition, resolving the haplotype structure of recurrent copy number variation of PTS-repeats, we were unable to confirm previous associations of 5 PTS-repeat copy alleles with protection against asthma in genome wide association studies. Instead, we revealed a significant association between *MUC7* haplotypic variation and oropharyngeal microbial composition. To our knowledge, our study is the first example of archaic introgression in Africa involving copy number variation of coding sequences.

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### Seasonal variation of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ in extant African suid enamel and its implications for fossil suid diets and paleoecology of hominin fossil sites

DEMING YANG<sup>1</sup> and KEVIN T. UNO<sup>2</sup>

<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, <sup>2</sup>Division of Biology and Paleo Environment, Lamont-Doherty Earth Observatory of Columbia University

Similar to early hominins, fossil suids experienced a delayed dietary response to the expansion of  $\text{C}_4$  grasslands during the Pliocene in Eastern Africa. By the early Pleistocene, nearly all suid lineages became  $\text{C}_4$  feeders, suggesting strong interspecific competition. Such competition may extend to some sympatric  $\text{C}_4$ -dependent hominins (such as *Paranthropus boisei*) and cercopithecines (such as *Theropithecus oswaldi*). Therefore, understanding dietary niche partitioning in fossil suids could provide a framework for studying variability in hominin diets.

Exploring niche partitioning in extant African suids through stable isotope analysis provides an exceptional foundation to understanding fossil suid ecology, including the vegetation and hydroclimate of their habitats. We selected sympatric bushpigs (*Potamochoerus*) and warthogs (*Phacochoerus*) from Malawi and the Democratic Republic of Congo. We investigated their dietary response to seasonality by analyzing  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  of enamel that was sequentially sampled along the growth axis of third molars and canines, with each sequence covering at least one seasonal cycle.

Two out of three individuals showed dietary changes in response to rainfall seasonality. One bushpig consumed more  $\text{C}_4$  in the rainy season ( $\text{C}_3/\text{C}_4$  mixed feeder) than in the dry season (primarily  $\text{C}_3$  feeder). In contrast, one warthog consumed more  $\text{C}_3$  in the rainy season ( $\text{C}_3/\text{C}_4$  mixed feeder) than in the dry season (primarily  $\text{C}_4$  feeder). The preliminary results demonstrate that serial sampling can resolve dietary niche partitioning among fossil suids, and potentially habitat preference and paleoclimate. Similar methods can be extended to other generalist mammals, particularly those with hypsodont or continuously growing teeth/tusks.

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### The value of understanding intraspecific relationships in comparative analyses

LU YAO<sup>1</sup>, HONGJIE LI<sup>2</sup>, CORRIE S. MOREAU<sup>3</sup>, RIPAN S. MALHI<sup>2</sup> and ROBERT D. MARTIN<sup>3</sup>

<sup>1</sup>Mammalogy/Sackler Institute, American Museum of Natural History, <sup>2</sup>Anthropology, University of Illinois at Urbana-Champaign, <sup>3</sup>Integrative Research Center, The Field Museum of Natural History

Phylogenetic comparative methods are often used when comparing multiple species in order to take phylogenetic non-independence into account. Some species are more closely related to each other than to others, so it is crucial to control for different degrees of relatedness. However, such methods are rarely used when analyzing data within species. We demonstrate that a grounded understanding of intraspecific relationships not only allows for taking phylogenetic relatedness into account in intraspecific

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comparative analyses but also provides crucial context for interpreting resulting patterns. We reconstructed an intraspecific mitogenome phylogeny for 135 long-tailed macaques and analyzed body size of specimens from islands and the mainland in Southeast Asia using both raw and phylogenetically corrected data. In our analyses, long-tailed macaques do not generally display dwarfing in body size on islands, although populations on Borneo and Sumatra have smaller body sizes than those living on the mainland or on islands of lesser size. Small body sizes of long-tailed macaques on Borneo may be driven by low soil quality on that island, and our phylogeny indicates that colonization of Sumatra by some Bornean lineages may have led to small-bodied populations on that island as well. Additionally, the phylogeny elucidates the origins of insular populations from the mainland, paving the way for proper comparison of specific insular and mainland populations. We stress the importance of controlling for phylogenetic relatedness in intraspecific comparisons for a full understanding of the results of comparative analyses.

### Phenetic Affinities of *Teilhardina* (Primates, Omomyidae) from the Powder River Basin of Wyoming Reveal the First Known Occurrences of *Teilhardina brandti* Outside the Bighorn Basin

GABRIEL S. YAPUNCICH, BLYTHE A. WILLIAMS and DOUG M. BOYER

Evolutionary Anthropology, Duke University

Fossil localities in the Powder River Basin (PRB) of northeast Wyoming have been dated to the earliest Wasatchian North American Land Mammal Age (Wa-0). However, specimens of the omomyid genus *Teilhardina* recovered from the basin have been attributed to the Wa-1 taxon *T. americana*. Since *T. brandti* (the Wa-0 taxon in the Bighorn Basin) was diagnosed after initial descriptions of PRB omomyids, here we re-examine *Teilhardina* specimens from the PRB to gauge if omomyid taxonomic diversity in the PRB has been underestimated.

Using *auto3Dgm* (an automated geometric morphometric method) and linear measurements of length and width, we evaluated the phenetic affinities of five *Teilhardina* specimens from separate PRB localities (including three mandibular fourth premolars [p4s] and four mandibular second molars [m2s]). Our comparative sample included 33 p4s and 48 m2s of *T. americana*, *T. asiatica*, *T. belgica*, *T. brandti*, *T. crasidens*, and *T. magnoliana*.

Principal components analysis indicate that two PRB m2 specimens most resemble *T. americana*, while the other two PRB m2s are most similar to those of *T. brandti*. One PRB p4 most resembles p4s of *T. americana*, while the other PRB p4s are most similar to those of *T. brandti*. Taxonomic

affinities are concordant in the two specimens preserving both p4 and m2. Overall tooth size and ratios of molar width to length are consistent with taxonomic affinities inferred from *auto3Dgm* results. We conclude that *T. brandti* was present in both the Powder River and Bighorn Basins during the earliest Eocene.

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### Childhood and Famine in Medieval London

SAMANTHA L. YAUSY and SHARON N. DEWITTE

Department of Anthropology, University of South Carolina

Famine, a scarcity of accessible food that causes widespread excess mortality, often targets population subgroups that differ from other biological or cultural subgroups in their frailty, or risk of death. Historically, famine mortality has been particularly pronounced among non-adults and the elderly, whose immune systems are often unable to cope with the dual insults of malnutrition and infectious disease that kill the majority of famine victims. This study compares famine and attritional burials from St. Mary Spital cemetery (SRP98, c. 1120-1540), which was used throughout the medieval period in London, England. Using data previously collected by Museum of London Archaeology researchers, this study evaluates the associations between famine burial, non-adult age, and four skeletal indicators of stress (cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia, and periosteal new bone formation) with hierarchical log-linear analysis. The results indicate a significantly higher frequency of linear enamel hypoplasia in the famine burials compared to attritional burials ( $p = 0.09$ ); this association is independent of an age effect. In contrast, the other stressors were not significantly associated with being buried in either the famine or attritional burials. The linear enamel hypoplasia results suggest that early exposure physiological stressors could impact overall frailty, and thus morbidity and mortality, particularly in the context of famine.

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### Arm Swing and the Evolution of Shorter Arms in *Homo*

ANDREW K. YEGIAN<sup>1</sup>, STEPHEN GILLINOV<sup>1</sup>, YANISH TUCKER<sup>1,2</sup> and DANIEL E. LIEBERMAN<sup>1</sup>

<sup>1</sup>Human Evolutionary Biology, Harvard University,

<sup>2</sup>Emmanuel College, Cambridge University

Why did selection favor shorter upper limbs, especially forearms, in *Homo*? Starting with *Homo erectus*, the genus *Homo* exhibit smaller intermembral indices (IMI) and brachial indices (BI) than australopiths. We hypothesized that shorter arms provide an advantage for both walking and

running, and that shorter forearms especially provide an advantage for running. We tested these hypotheses with a two-segment biomechanical model of arm swing. Eleven subjects walked and ran on a treadmill with motion capture of their body segments. Subjects walked and ran with their elbows bent (short arm conditions) or straight (long arm conditions). Muscle moments at the shoulder and elbow were calculated from the motion capture data. Supporting the first hypothesis, short arms had 21% smaller shoulder moments than long arms in walking, and 25% in running. A tradeoff existed when bending the elbow to shorten the arm: the shoulder moment decreased, but the elbow moment increased by 47% in walking and 20% in running. The smaller proportional increase in running suggests that the stereotypical behavior of bent elbows during running is gait-specific. The subjects also walked and ran with normal arm configurations but with added masses in the hands, functionally lengthening the forearms. Longer forearms increased the elbow moments, but the increase was three times greater during running than during walking, supporting the second hypothesis. Altogether, these results suggest that walking and running favored the evolution of smaller IMI in *Homo*, but the evolution of smaller BI was likely due to selection for long distance running.

### Opportunity costs from potential nighttime activities trade off against time allocated to sleep behavior among Tsimane hunter-horticulturalists

GANDHI YETISH<sup>2,3</sup>, HILLARD KAPLAN<sup>2</sup> and MICHAEL GURVEN<sup>1</sup>

<sup>1</sup>Anthropology, University of California at Santa Barbara, <sup>2</sup>Anthropology, University of New Mexico, <sup>3</sup>Semel Institute, University of California at Los Angeles

Despite the myriad and marked negative health consequences of short sleep, people still report sleeping insufficiently at high rates. In an attempt to improve our understanding of "normal" sleep, recent studies have implemented an evolutionary perspective and expanded studies of sleep patterns in small-scale, subsistence societies. We present a model of sleep regulation as a behavior, subject to the principles of time allocation tradeoffs and opportunity costs in the pursuit of optimizing sleep on a night-by-night basis. To provide initial tests of this model, we studied sleep among Tsimane hunter-horticulturalists in Amazonian Bolivia. Using a mixture of objective sleep measures from wrist-worn accelerometry and experiential methods from daily interviews, we compared how sleep patterns vary at the within-individual level to variation at the inter-individual level. We also tested how different nighttime activities affect sleep onset and total sleep times. Given the observation that nighttime food acquisition had the largest effect on

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sleep, we tested predictors of nighttime hunting, fishing, and plant-food acquisition. We found that sleep varied substantially more within individuals than between them, that food production and television watching had the strongest negative associations with sleep duration, and that food production was far more likely when people reported not eating any dinner because of not having any food. We interpret these findings as support for the model of sleep as behaviorally regulated as a reaction norm, sensitive to highly variable opportunity costs.

### Adaptive Evolution of *TCIRG1*: A Gene Involved in Bone Development and Remodeling

AN-DI YIM<sup>1</sup>, SCOTT A. WILLIAMS<sup>2,3</sup> and TODD R. DISOTELL<sup>2,3</sup>

<sup>1</sup>Department of Anthropology, University of Illinois at Urbana-Champaign, <sup>2</sup>Center for the Study of Human Origins, Department of Anthropology, New York University, <sup>3</sup>New York Consortium for Evolutionary Primatology

Long bone cross-sectional properties are reflective of mechanical loading environment and have been used to make behavioral inferences. However, the genetic basis of this complex morphology remains unknown. Human chromosome region 11q12-13 has been identified multiple times as a potential region housing gene(s) associated with variation in bone mineral density (BMD) and cross-sectional geometric properties. Specifically, two candidate genes—*LRP5* and *TCIRG1*—have been singled out from this region because of their functional roles in bone development and remodeling and their associations with diseases of the skeleton such as osteoporosis and osteopetrosis.

Given that selection acting on a phenotypic character would also have an effect on the underlying genetic mechanism and vice versa. We expect that evolutionary changes in bone cross-sectional properties would be reflected in the underlying gene sequences. Using selection analysis, we estimated the rate of nonsynonymous changes ( $d_n$ ) to synonymous changes ( $d_s$ ) of these two genes in 12 primate species. Preliminary results showed that both loci were under purifying (negative) selection, which is expected as mutations in both genes would lead to detrimental consequences. Specifically, *TCIRG1* showed species-specific  $d_n/d_s$  ratios as opposed to the little variation observed in *LRP5*. The branch leading to the human-chimpanzee clade also has a significantly higher ratio than the rest of the tree. Whether phenotypic variation in cross-sectional geometric properties in these primate species correspond to the change in evolutionary rate of *TCIRG1* will be a main focus for further study.

### A comparative bioarchaeological analysis of two Formative Period communities from the lower Rio Verde, Oaxaca, Mexico

AARON J. YOUNG<sup>1</sup>, ARION T. MAYES<sup>2</sup>, JEFFREY BRZEZINSKI<sup>3</sup>, SARAH BARBER<sup>4</sup> and ARTHUR JOYCE<sup>5</sup>

<sup>1</sup>Anthropology, San Diego State University, <sup>2</sup>Anthropology, San Diego State University, <sup>3</sup>Anthropology, University of Colorado, Boulder, <sup>4</sup>Anthropology, University of Central Florida, <sup>5</sup>Anthropology, University of Colorado, Boulder

The lower Rio Verde Valley of Oaxaca, Mexico has produced copious amounts of archaeological sites as well as a number of burials. The Early Formative period (1600 – 850 BCE) shows the earliest human settlement, which intensifies immensely during the Late Formative period (300 BCE – CE 250). A bioarchaeological analysis of Cerro de la Virgen (150 BCE – CE 500), which was first excavated in 2005 and most recently in 2016, is discussed here with comparisons to the site of Rio Viejo (300 BCE - CE 250). Both sites were occupied during overlapping time periods. However, the sites differ in their functions within the lower Rio Verde Valley communities. Rio Viejo is considered to be the region's centralized polity and main political authority, whereas Cerro de la Virgen is a secondary center, and a periphery community. To date, excavations of Cerro de la Virgen have produced four individuals with varying degrees of preservation, representing both primary interments and offerings. The most complete individual (60%) shows signs of extensive dental wear and oral pathology. Through a comprehensive bioarchaeological analysis, we compare these individuals to seven individuals from the Terminal Formative period excavated at the site of Rio Viejo. The soil in much of the lower Rio Verde Valley consists of heavy clay sediment which adheres to bone and can distort or obstruct certain bony features, and affect overall preservation; making analysis of burials from this period and important endeavor in documenting the biological history of the region.

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### High brachial and crural indices in Island Foxes: analysis of island fox and human populations and applications for understanding the pygmy body type

COLLEEN B. YOUNG and LIBBY W. COWGILL  
Department of Anthropology, University of Missouri

The evolutionary history of hominins with small body size known as pygmies is an unresolved issue in biological anthropology. Several hypotheses compete to explain the convergent evolution of multiple populations with extremely small body stature (height < 150cm). Food limitation, thermoregulation, mobility, and life history hypotheses contribute adaptive scenarios for

understanding why small body sizes evolved. Importantly, many pygmy populations are found on islands, yet research hasn't used an island lens to explain small human body sizes. To test published hypotheses on why small body size in multiple populations independently evolved, additional research should focus on understanding if and how island pygmy humans follow trends seen in other island pygmy organisms, and whether pygmy humans in mainland contexts follow these island trends.

Results show that island humans follow allometric patterns similar to insular organisms such as dwarfed island foxes. Both island fox (N=40) and island human (N=65) samples have significantly shorter limbs than mainland counterparts ( $p < .05$ ). However, brachial and crural indexes are significantly higher for island organisms compared to mainland counterparts ( $p < 0.01$ ), suggesting that reduced limb length is not achieved via distal segment shortening. Pygmies in rain forests of Africa follow this trend. Both island and mainland pygmy humans have significantly higher brachial and crural than non-pygmy counterparts ( $p < .05$ ). Thus, pygmy humans on mainland and islands follow the same unique patterning of limb shortening that we see in non-human dwarfed island populations. From these findings, and further applications of island theories, conclusions are drawn regarding the evolution of the pygmy body type.

*This research is funded by the National Science Foundation's Graduate Research Fellowship.*

### Kinship Structures and Victim Origins in a Mass Human Sacrifice: Biodistance Analysis of Intracemetery Dental Phenetic Variation, Temple of the Sacred Stone, Túcume, Peru

JOHANNA E. YOUNG<sup>1</sup>, HAAGEN D. KLAUS<sup>1</sup>, J. MARLA TOYNE<sup>2</sup> and BERNARDA DELGADO<sup>3</sup>

<sup>1</sup>Department of Sociology and Anthropology, George Mason University, Fairfax, VA, <sup>2</sup>Department of Anthropology, University of Central Florida, Orlando, FL, <sup>3</sup>Director, Museo del Sitio de Túcume, Lambayeque, Peru

From 1350-1532 A.D., some 117 children and men were sacrificed and buried in recurrent episodes of ritual killing at the Temple of the Sacred Stone at Túcume, north coast of Peru. Cut marks, victim burial, and the overall nature of the killings point a highly structured and symbolically charged sequence of sacrifices. To further investigate the cultural and ideological messages embodied by these rituals, we conducted biodistance analysis of the victims using inherited tooth size and nonmetric dental traits.

North coast societies were organized into endogenous polities and kinship relationships were often encoded in the spatial organization of tombs and cemeteries. We tested the hypothesis

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that Túcume victims were related kin and that the living represented such social distinctions in the placement of the bodies after sacrifice. Standard dental metric and nonmetric data were collected from the 77 best-preserved dentitions. Intraindividual Euclidian distances were calculated using the furthest neighbor hierarchical cluster analysis algorithm validated via a silhouette measure of cohesion. The results suggest that some victims were indeed close kin, but burial placement was random and uncorrelated to phenetic structures. We reject the hypothesis. Spatial representations of kinship was immaterial. These rituals likely transformed constructions of personhood or other aspects of victim identity, perhaps separating them from the world of the living in a symbolic inversion of proper burial. Further multivariate comparisons of victim dental trait variation show a high degree of similarity with regional Lambayeque populations indicating that victims were not foreigners but had been drawn from local populations.

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### **The evolution of the human pelvis: A developmental genetics and functional genomics perspective**

MARIEL YOUNG, EVELYN JAGODA, HEATHER DINGWALL and TERENCE D. CAPELLINI  
Human Evolutionary Biology, Harvard University

Due to selective pressures associated with bipedality, childbirth, and thermoregulation, the pelvic phenotypes of humans and other hominins are drastically different from that of our closest living relatives, chimpanzees. These phenotypic differences between humans and chimps are likely present from birth, suggesting that natural selection acted drastically to affect embryonic pelvic formation and growth, processes that are genetically encoded and subject to epigenomic control. To date, little is known regarding the developmental biology of the pelvis, and even less is known regarding the developmental genetic changes in humans that have shaped the pelvis and made its morphology distinctive from extant apes. We have begun to significantly fill both of these gaps in knowledge by exploring the epigenomic and transcriptomic control of chondrogenesis during pelvic development in the mouse. We have used the assay for transposase-accessible chromatin (ATAC-seq) to generate datasets that reveal open chromatin profiles for each individual pelvic rudiment (ilium, ischium, and pubis), allowing for the identification of a number of putative regulatory regions that are distinct between individual bones of the pelvis and may have been potential targets of selection in hominins. We have also been performing similar experiments on the transcriptome using RNA-sequencing, which allows us to identify

differentially expressed genes in the pelvic rudiments. Using comparative genomics, analyses of select open chromatin regions reveals putative functional mutations potentially underlying adaptive changes in human pelvic growth. These regions will undergo functional testing using the mouse as a model system in the future.

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### **Anatomical Determinants of Dysfunction Inform the Evolution of the Human Shoulder**

NATHAN M. YOUNG<sup>1</sup>, NEIL T. ROACH<sup>2</sup>, SAFA HERFAT<sup>1</sup>, MICHAEL RAINBOW<sup>3</sup>, MEIR MARMOR<sup>1</sup>, BRIAN FEELEY<sup>1</sup>, TIM BAUM<sup>4</sup> and MICHAEL BEY<sup>4</sup>  
<sup>1</sup>Orthopaedic Surgery, University of California San Francisco, <sup>2</sup>Human Evolutionary Biology, Harvard University, <sup>3</sup>Mechanical and Materials Engineering, Queen's University, <sup>4</sup>Bone and Joint Center, Henry Ford Hospital

We previously demonstrated that fossil hominins support a scenario in which the lateralized shoulder joint configuration found in modern humans evolved from the more cranial organization seen in African apes. This trajectory is consistent with selection against overhead functions (e.g., climbing) and for more human-specific behaviors (e.g., tool use). Human populations retain remarkable variability in the skeletal shape and configuration of the shoulder, which may reflect both functional tradeoffs and weak costs associated with more primitive shape configurations. We predicted these configurations experience higher shear forces during lateralized behaviors leading to a higher lifetime incidence of rotator cuff injury (RCI). To test the second of these predictions, we compared computed tomography (CT) data of the scapula from individuals diagnosed with a rotator cuff tear and age-matched controls (n=48). To characterize shape, we collected three-dimensional landmark data, performed Procrustes superimposition to remove the effect of orientation and scale, a Canonical Variates Analysis (CVA) to identify shape differences that maximize between group variation, and ANOVA to test for significance of mean shape differences. RCI and control populations exhibit a significant difference in mean shape ( $F=1.77$ ,  $df=77$ ,  $p<0.0001$ ), the former having a more cranial orientation of the glenoid and scapular spine, a reduced supraspinatus attachment area, and a smaller attachment area and altered orientation of the teres major. These results are consistent with a direct role of selection in the hypothesized LCA-hominin evolutionary trajectory and help explain the observed variability of scapular shape in modern human populations.

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### **Placentophagy's Effects on Postpartum Maternal Affect, Health, and Recovery**

SHARON M. YOUNG<sup>1</sup>, LAURA K. GRYDER<sup>1,2</sup>, CHAD CROSS<sup>3</sup>, DAVID ZAVA<sup>4</sup>, DAVID W. KIMBALL<sup>4</sup> and DANIEL C. BENYSHEK<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Nevada, Las Vegas, <sup>2</sup>School of Community Health Sciences, University of Nevada, Las Vegas, <sup>3</sup>Department of Mathematics, Nevada State College, <sup>4</sup>ZRT Laboratory, Beaverton, Oregon

Postpartum ingestion of the placenta by the mother, or placentophagy, has recently gained popularity among women in industrialized countries, despite its absence in the ethnographic literature as a longstanding traditional practice in any human culture. Placentophagy proponents claim that ingesting the placenta provides a host of benefits to the postpartum mother, including relief or prevention of depressive symptoms, increased energy, and improved maternal-infant bonding, among others. These claims are based on anecdotal accounts from mothers who have engaged in the practice, and have not been subjected to rigorous, scientific evaluation. To evaluate the effects of placenta ingestion on maternal postpartum health and recovery, a double-blind placebo-controlled pilot study was conducted where 27 participants received either their own dehydrated and encapsulated placenta (n=12) or a placebo supplement (n=15). Measurements of mood, bonding, and fatigue, as well as hormone measures were taken 4 times: during the 36th week of pregnancy, within 72 hours postpartum (pre-supplementation), between days 5 and 7 postpartum (post-supplementation), and approximately 3 weeks postpartum. While there were no significant differences in psychometric or hormone measures between placenta and placebo group participants across postpartum meetings, placenta group participants experienced postpartum decreases in depressive symptoms and fatigue that were not experienced by control group participants. These results suggest that placenta supplements may provide a modest benefit, for postpartum maternal mood, energy, and recovery. Additionally, because placenta supplements contain detectable concentrations of steroid hormones with time-sensitive physiological effects, the role of these substances in postpartum mood in this study warrants further investigation.

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### Identification of *Mycobacterium tuberculosis* in dental calculus from the Smithsonian's Huntington Collection

SOLEIL E. YOUNG and ALANNA L. WARNER-SMITH  
Anthropology, Syracuse University

Diagnosing tuberculosis (TB) is challenging for bioarchaeologists, as not all who are infected form associated bone lesions. Currently, the only way to diagnose tuberculosis in skeletal remains using molecular techniques is to drill and sample bone, an invasive and destructive procedure. However, like bone, dental calculus can also trap and preserve DNA. In this poster, we present the first confirmation that TB can be diagnosed through analysis of dental calculus. Following established aDNA procedures, we analyzed dental calculus from seven unaccessioned mandibles from the Smithsonian Institution's George S. Huntington Anatomical collection. This collection is comprised of individuals collected between 1892 and 1920 in New York City. Associated vital records allow researchers to assess which individuals died of TB, and this archival evidence was compared with results from molecular analysis. We performed DNA extractions from decalcified calculus to target the IS6110 insertion sequence in the *Mycobacterium tuberculosis* 16s rRNA gene, which is species-specific and present throughout the genome. Calculus collected from two mandibles tested positive for the presence of IS6110, demonstrating that it is possible to amplify and isolate *Mycobacterium tuberculosis* from historic dental calculus. We also discuss an expanded study, which examines the dental calculus from six Irish individuals in the Huntington collection, two of whom are recorded as having died of tuberculosis.

Funding for this project was supported by a grant from the Renée Crown Honors Program at Syracuse University.

### Analysis of Growth Disruptions in two Burial Populations in the Greek Colony of Himera

ABDUL H. ZAHID<sup>1</sup>, BRITNEY KYLE<sup>2</sup>, NORMA LONOCE<sup>3</sup>, APRIL SMITH<sup>4</sup>, STEFANO VASSALLO<sup>5</sup>, PIER FRANCESCO FABBRIO<sup>3</sup> and LAURIE J. REITSEMA<sup>4</sup>

<sup>1</sup>Department of Anthropology, University of California, Berkeley, <sup>2</sup>Department of Anthropology, University of Northern Colorado, <sup>3</sup>Department of Cultural Heritage, Università del Salento, <sup>4</sup>Department of Anthropology, University of Georgia, <sup>5</sup>Director of Archaeology, Regional Archaeological Superintendence of Palermo, Italy

This study examines growth disruption between individuals buried in two different styles, flexed and supine, at the Greek colony of Himera (Sicily, Italy, 648-409 BCE). Himera was a multiethnic site where many cultures coexisted and hybridized. Individuals buried in different styles may have had different cultural affiliations, and thus may

vary in their lived experiences, including stress and health. At Himera, flexed burials are theorized to represent local Sicilians, and supine burials are theorized to represent non-local Greeks. However, since this is unconfirmed, we test the null hypothesis that flexed and supine graves will show equal prevalence of growth disruption, as evidenced by linear enamel hypoplasia (LEH) and stunted growth at Himera, to determine if skeletal stress varies in groups with different cultural affiliations.

LEH was scored following standards outlined in The Global Health Project Data Collection Codebook, and average stature was calculated using multiple stature regression formulae. Analysis of growth disruptions in flexed and supine burials showed no significant differences between the two groups ( $X^2 = 1.37$ ,  $p = 0.24$ ). Males and females in both groups also displayed nearly identical prevalence of LEH ( $X^2 = 0.04$ ,  $p = 0.84$ ). These findings support the null hypothesis, and tentatively suggest that Himerans and non-local Greeks had similar life experiences, regardless of their preferred burial style. Alternatively, cultural buffering and/or catch-up growth could explain similar prevalence of growth disruption despite different levels of stress experienced during life.

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### Geometric Morphometrics of the Neonatal Pelvis in Strepsirrhine Primates

SARAH M. ZALESKI<sup>1</sup>, TIMOTHY D. SMITH<sup>2,3</sup>, JESSE W. YOUNG<sup>4</sup> and VALERIE B. DELEON<sup>1</sup>

<sup>1</sup>Department of Anthropology, University of Florida, <sup>2</sup>School of Physical Therapy, Slippery Rock University, <sup>3</sup>Department of Anthropology, University of Pittsburgh, <sup>4</sup>Department of Anatomy and Neurobiology, Northeast Ohio Medical University

Previous research has demonstrated pelvic morphological differences between adult vertical clinger and leapers (VCLs) and arboreal quadrupeds (AQs). This study analyzes pelvic CT data of cadaveric strepsirrhine primates for the effect of locomotor mode on pelvic shape among neonates. The sample includes large-VCL *Propithecus coquereli* (n=2) and small-VCLs *Galago moholi* (n=2), *Galago senegalensis* (n=1), and *Hapalemur griseus* (n=1). Arboreal quadrupeds practicing occasional leaping include *Eulemur mongoz* (n=2) and *Cheirogaleus medius* (n=1), while *Nycticebus pygmaeus* (n=1) and *Loris tardigradus* (n=1) represent non-leapers. Two trials of thirty-seven 3D landmark coordinates representing the right and left pelvic girdle and sacral promontory were collected using Amira software and analyzed in the R Geomorph package. Measurement error analyses indicated good repeatability and average landmark precision of 0.0923mm. Principal components analysis (PCA) of averaged trials suggests both

phylogenetic and functional effects on neonatal pelvic shape. All leapers exhibit a wider pelvis with laterally displaced ilia and ischia relative to nonleapers. Nonleapers have mediolaterally narrower and dorsoventrally deeper pelves. Large bodied leapers are distinct from small bodied leapers based on lateral flaring of the anterior superior iliac spine. Lemurids cluster closer than expected based on locomotor differences, indicating a possible phylogenetic influence. This study suggests that pelvic shape differences exist among locomotor groups prior to the onset of locomotor behavior.

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### Does Size Matter? Using Size Variation to Diagnose the Presence of Multiple Species in Subfossil Lemur Samples

ANDREW J. ZAMORA<sup>1</sup> and JAMES P. HERRERA<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of Massachusetts - Amherst, <sup>2</sup>Department of Mammalogy and Division of Vertebrate Paleontology, American Museum of Natural History

Limited and often highly fragmented fossil remains can make inferring the number of species in an extinct genus difficult. Size differences among specimens of similar fossils have often been used to diagnose species, and size variation in modern taxa can be used to evaluate if fossil taxa show greater variation than observed in extant species. If a fossil assemblage shows greater size variation than its modern counterparts, we can reject the single-species hypothesis.

We report analyses on 32 crania encompassing four subfossil taxa (*Megaladapis*, *Paleopropithecus*, *Archaeolemur*, and *Mesopropithecus*) using seven craniodental measurements. The same measurements were taken from 59 crania of three extant lemur species (*Propithecus verreauxi*, *Lepilemur leucopus*, and *Eulemur albifrons*). We used a bootstrapping procedure to sample trait values from each modern species at sample sizes equal to the fossil taxa for each trait. This allowed us to account for the limited sample sizes of the extinct specimens' trait measurements. Coefficients of variation (CV) for these bootstrapped "fossil" samples were then calculated to create a sampling distribution of CVs.

Empirical CVs for *Megaladapis* and *Archaeolemur* exceeded the bootstrapped CVs seen in modern crania in a majority of traits, suggesting the specimens from these genera likely represent multiple species based on size differences. *Mesopropithecus* specimens fell within the modern range of variation while results on *Paleopropithecus* are limited due to specimen quality. Our results lend support to multiple species being present in some subfossil genera

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while emphasizing the importance of evaluating the extent of size variation for taxonomic diagnosis.

### ***Oreopithecus bambolii* is still an “enigmatic anthropoid”**

CLÉMENT ZANOLLI<sup>1</sup>, DAVID M. ALBA<sup>2</sup>, M. CHRISTOPHER DEAN<sup>3</sup>, JOSEP FORTUNY<sup>2,4</sup>, ROBERTO MACCHIARELLI<sup>5,6</sup> and LORENZO ROOK<sup>7</sup>

<sup>1</sup>UMR 5288 AMIS CNRS, Université de Toulouse III - Paul Sabatier, France, <sup>2</sup>Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Spain, <sup>3</sup>Department of Cell and Developmental Biology, University College of London, UK, <sup>4</sup>Centre de Recherches en Paléobiodiversité et Paléoenvironnements, Muséum National d'Histoire Naturelle, Paris, France, <sup>5</sup>UMR 7194 CNRS, Muséum National d'Histoire Naturelle, Paris, France, <sup>6</sup>Unité de Formation Géosciences, Université de Poitiers, France, <sup>7</sup>Dipartimento di Scienze della Terra, Università di Firenze, Italy

*Oreopithecus bambolii* lived in the Tusco-Sardinian archipelago between c. 8.3 and 6.7 Ma. Its evolution in an insular context was likely responsible for the development of a number of peculiar cranio-dental features which render the assessment of its phylogenetic relationships quite problematic compared to other late Miocene Eurasian catarrhines. Even if its dentition shows a blend of hominoid, cercopithecoid-like and unique features (such as the development of a molar centroconid), *Oreopithecus* is regarded by several researchers as a derived member of the dryopithecine subfamily.

By using high resolution X-ray microtomography, we detailed the inner structural morphology of three *Oreopithecus* lower permanent molar crowns (the M<sub>1</sub> FS1996#Fi98, the M<sub>2</sub> FS1996#Fi99 and the M<sub>3</sub> FS1996#Fi97) from the Sardinian site of Fiume Santo and compared their 3D enamel thickness (ET) topographic distribution and enamel-dentine junction (EDJ) morphology with those from representatives of some European fossil anthropoids (pliopithecoid taxa belonging to *Pliopithecus* and the hominoids *Dryopithecus* and *Ouranopithecus*), extant hominoids (*Homo*, *Pan*, *Gorilla*, *Pongo*, *Hylobates*), and *Papio*.

In *Oreopithecus*, the pattern of ET topographic distribution, where the thickest tissue is found along the mesiodistal axis of the crown, is unique among the taxa considered in this study. The results of the 3D geometric morphometric analysis (GMA) discriminate the relatively high dentine horns and EDJ conformation of *Oreopithecus* from the typical cercopithecoid condition, on the one hand, and from the fossil and extant hominoid patterns (including in *Dryopithecus*). *Oreopithecus* also differs from the pliopithecoid condition, except for the M<sub>1</sub> IPS41955 that closely resembles the former.

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### **Advancing ethical literacy through case studies**

KRISTINA M. ZARENKO<sup>1</sup> and JENNIFER EYRE<sup>2</sup>

<sup>1</sup>Anthropology, University of South Carolina, <sup>2</sup>Anthropology, New York University

The purpose of this presentation is to demonstrate the importance of fostering ethical literacy in the next generation of anthropologists. This presentation will describe a method for increasing ethics knowledge through the use of case study development by the AAPA Ethics Fellows Program.

Anthropologists frequently face ethical issues in research and professional contexts, therefore it is important to provide the next generation with the tools to appropriately address these situations. For this reason, ethical case studies directly applicable to biological anthropologists are being created by the AAPA Ethics Committee fellows. The purpose of these case studies is to create a resource for members of the AAPA community who would like further information about methods useful for resolving ethical quandaries or who wish for teaching resources to expand the ethical knowledge of students. Working through hypothetical case studies will provide individuals an important foundation in critical ethical thinking that may be applied to real life ethical situations.

Potential case studies were submitted to and vetted by the Ethics Committee before development. The selected cases are applicable for a broad range of AAPA members and possible research situations. The fellows applied the six step ethical problem-solving methods from Ethics for Anthropological Research and Practice by Whiteford and Trotter to expand each case study scenario. This presentation will also describe the development methods and the scope of the case studies.

### **Bread and Porridge in Early Berlin: A Palaeodietary Analysis of the Medieval Cemetery at Petriplatz, Germany**

MARIANA E. ZECHINI<sup>1</sup>, KRISTINA KILLGROVE<sup>1</sup>, JANE HOLMSTROM<sup>1</sup>, BENJAMIN J. SCHAEFER<sup>2</sup> and BETHANY L. TURNER<sup>2</sup>

<sup>1</sup>Department of Anthropology, University of West Florida, <sup>2</sup>Department of Anthropology, Georgia State University

Dating from the late 12th century, the cemetery of Petriplatz contains some of the earliest residents of modern Berlin. With little documentary evidence from Berlin at this time, the rise of the city is not as well known as other European capitals and the daily life of its inhabitants is therefore

poorly understood. This research employs stable isotope analysis from teeth and bone from 22 individuals from Petriplatz to understand childhood and adult diets. Given the centrality of diet and subsistence in shaping the lifespan, diet reconstruction is an excellent avenue for gaining further insights into this period.

The  $\delta^{13}\text{C}_{\text{ap}}$  enamel results, indicating childhood diet, fall within the expected range of C<sub>3</sub> food-stuffs (-14.8‰ to -13.1‰), aligning with historical records that note Medieval Germans were eating dark bread and wheat porridge. Although some historians suggest males and females consumed different food, a t-test indicates no significant difference in diet ( $p=0.22$ ) between males (-13.5‰) and females (-13.9‰).

Values from Petriplatz are also compared to those from other Medieval German sites. For example, the mean  $\delta^{13}\text{C}_{\text{ap}}$  enamel data from Regensburg, located in southeast Germany, are not statistically different from Petriplatz (-13.9‰ and -13.7‰, respectively; t-test  $p=0.15$ ), suggesting a similar childhood diet.

Results obtained thus far reveal homogeneity in carbohydrate consumption in early childhood in Medieval Germany. Ongoing analysis of C and N isotopes in rib collagen will provide additional data on adult diet at Petriplatz. This palaeodietary study has produced the first isotopic data from skeletons from Medieval Berlin.

### **Highly Protracted Hindlimbs and a Forward Foot Placement Increase Stability when Walking on Arboreal Substrates**

ANGEL ZEININGER<sup>1</sup>, MICHAEL C. GRANATOSKY<sup>2</sup> and DANIEL SCHMITT<sup>1</sup>

<sup>1</sup>Evolutionary Anthropology, Duke University, <sup>2</sup>Organismal Biology and Anatomy, University of Chicago

As a primarily arboreal radiation, primates face the challenge of having to move safely on substrates that are relatively narrow, flexible, and experience unpredictable perturbations. While there are many mechanisms arboreal primates use to maintain stability, little attention has been paid to the placement of the hindlimb relative to the center of mass (COM). Placing the foot closer to the projection of the COM may reduce the tendency for the body to topple by reducing forward or backward pitch. We hypothesize that, when walking on arboreal supports, primates use highly protracted hindlimbs to place the foot beneath the COM. To test this, hindlimb protraction angles and foot placement (as a percentage of trunk length) were measured in videos of arboreal and terrestrial walking in lemurs, monkeys, and apes (ground only). On the pole, all primates placed the foot beneath or anterior to the COM. Lemurs and Old World monkeys used more protracted hindlimbs on the pole and placed their foot an average of 51% of trunk length on the

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pole, but only 43% of trunk length on the ground. New World monkeys used highly protracted hindlimbs regardless of substrate type and placed their foot at 70% to 90% of trunk length. On the ground, chimpanzees and gorillas placed their foot at 51% and only 45% of trunk length, respectively. Highly protracted hindlimbs place the foot under or anterior to the COM, thereby increasing full-foot contact and braking force duration, and possibly moderating forward pitch to ensure stability on arboreal supports.

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### Bio-cultural analysis of an early 18<sup>th</sup> century noble family in Transylvania, Romania

KATIE ZEJDLIK<sup>1</sup>, ZSOLT NYÁRÁDI<sup>2</sup>, RACHEL SANDQUIST<sup>3</sup> and ANDRE GONCIAR<sup>4</sup>

<sup>1</sup>Anthropology & Sociology, Western Carolina University, <sup>2</sup>Archaeology, Haáz Rezső Museum, Székelyudvarhely, Romania, <sup>3</sup>Anthropology, Penn State, <sup>4</sup>Archaeology, ArchaeoTek-Canada

Recent excavation of a medieval church in Patakfalva (Valeni), Romania uncovered the interment of three individuals within a family crypt beneath the pulpit. One of the coffins within the crypt was well preserved and maintained the family name: Ferenci, and date of interment: 1743, via nails pounded into the lid of the coffin. The individual was accompanied by the extended primary burial of an elderly male and the poorly preserved, semi-flexed interment of an elderly female. Osteological analysis of the remains interred in the crypt found that all individuals showed well-formed muscle markings and the presence of osteoarthritis. Grave 10, who appeared to be the central figure within the crypt, also displayed evidence of a healed fracture of the left clavicle, left rib 1, and left fibula. His sacroiliac joints presented ankyloses and the inferior articular facets of his 5<sup>th</sup> lumbar vertebra had been modified. In addition to the severe osteoarthritis, grave 10 showed an active dental abscess at the location of his lower left premolar and first molar. The Ferenci family was a well-known noble family within this region as indicated by written record and oral history. Cultural interpretation of this burial indicates that the interment of two males is common, whereas the interment of a female within the family crypt is less so. Furthermore, the presence of healed fractures is not unusual as the nobleman would have been expected to have acted as a strong leader in battle through skills in swordsmanship and horsemanship.

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### Bilateral Asymmetry in Cross-Sectional Properties Indicates Periarticular Plasticity in the Distal Humerus of Modern Humans

KAYA G. ZELAZNY and CHRISTOPHER B. RUFF

Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

Features of the distal humeral shaft as well as distal articular and periarticular regions have been used to distinguish fossil hominin taxa, but the degree to which these traits may be influenced by functional use during life has not yet been systematically assessed. It is well-established that cross-sectional properties of diaphyseal bone respond developmentally to mechanical loading, as reflected in bilateral asymmetry of humeral mid-diaphyseal sections corresponding to handedness. This study tests the hypothesis that bilateral asymmetry in bone strength (polar section modulus,  $Z_p$ ) of distal humeral and periarticular sections will be correlated with bilateral asymmetry in bone strength at 40% of bone length from the distal end, while articular properties will remain invariant with regard to asymmetry in diaphyseal strength.

We used peripheral Quantitative Computed Tomography to assess bilateral asymmetry in cross-sectional properties of two population samples of modern humans of varying body size and humeral asymmetry (N=22) at 6 sections along the distal humerus. Asymmetry in strength at 40% of bone length was highly correlated with strength asymmetry at 18% of length. It was moderately correlated with strength asymmetry at two sections through the olecranon pillars as well as with biepicondylar breadth, but was not correlated with asymmetry in articular cross-sectional area or surface area (as measured from surface scans obtained by laser scanning). These results indicate that the distal shaft and periarticular region of the humerus respond plastically to functional loading, which has implications for both behavioral reconstructions and taxonomic assignments of fossil hominin taxa.

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### Divided Zygomata in Neolithic and Dynastic Northern Chinese Populations

QUN ZHANG<sup>1</sup>, PAUL C. DECHOW<sup>2</sup>, QUANCHAO ZHANG<sup>1</sup> and QIAN WANG<sup>2</sup>

<sup>1</sup>Department of Archaeology, Jilin University,

<sup>2</sup>Department of Biomedical Sciences, Texas A&M University College of Dentistry

Divided zygomata (DZ) present in contemporary human populations with highest incidence in eastern Asia and southern Africa (up to 6.5%). However, the developmental mechanisms of DZ is unclear. In this study, 1145 skulls, housed in Jilin University Research Center for Chinese Frontier Archaeology, from various human populations living in Northern China from the Neolithic era to recent dynasties (5,000 to 300 years B.P.) were investigated for DZ phenomenon. Fourteen skulls were identified with DZ, giving an incidence of 1.2% in the collection, yet up to 4.5% in North Asian and North Chinese ethnic groups. Among them, ten skulls had bilateral DZ, four skulls had unilateral DZ, suggesting both genetic and epigenetic effects. All skulls demonstrated morphological features recently recognized by

Wang and Dechow (2016). In skulls with unilateral DZ, the superior division of the zygoma was generally slender while the inferior division of the zygoma and the adjacent temporal and maxillary bones were generally more robust; while in skulls with bilateral DZ, the maxillae were generally more laterally extended, providing areas for masseter muscle attachment. Preliminary assessments of three-dimensional CT images demonstrated differences of the distribution of bone mass in the facial skeletons between two sides in unilateral DZ skulls, and between bilateral DZ skulls and non-DZ skulls, indicating morphological and functional consequences of the DZ phenomenon. This is the first time that the DZ condition was investigated in ancient human populations. Further studies into this condition will deepen our understanding of human skull development plasticity, variation, and recent evolution.

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### Diet Reconstruction of the Ancient People from Chinese Silk Road: The Tooth Wear of the Bronze-Iron Age Population From Jiayi Cemetery in Xinjiang, China

WENXIN ZHANG, HUIJIE ZHAO, SHIYU YANG, ANQI WANG, XINGYU MAN, NINGNING LIANG and XIAOFANG GAO

Department of Archaeology,, Jilin University, China

This paper present a study on the tooth from Jiayi Cemetery (10<sup>th</sup>-2<sup>nd</sup> Century BC), which is located in Turpan Depression of northwest China, an essential spot during the formative period of Chinese Silk Road. Here we try to reconstruct the diet of Jiayi ancient population, by observing and analyzing their tooth wear and also other oral features.

We recorded the wear stages of each tooth according to Smith (1984). The results suggest that Jiayi population present heavy tooth wear with an average score of 4.0. When compared with other 3 Chinese populations, Jiayi population show heavy tooth wear both in anterior and posterior sides. Meanwhile, we noticed the remarkable and high-frequent oblique wear, especially on molars among Jiayi population. The results also suggest that very few individuals had caries (1.7% of teeth, N=1115). Other oral features, including exostosis (14.5%), ante-mortem tooth loss (43.5%), calculus (71.0%), abscessing (46.4%) and periodontal disease (37.7%) were also discussed in our study (by individuals, N=69).

The results indicate that meat occupied a main part of Jiayi population's diet, while some kinds of hard food caused the heavy and oblique wear of posterior teeth. Ethnological evidence shows that some herdsmen living in the north of China eat hard foods like fried millet, as it contains high energy and is easy to carry on horse. This might be a tradition passed on from their ancestors 3000 years ago. Further researches on

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stable carbon and nitrogen isotope analysis and paleoethnobotany can provide more information on our hypothesis.

### Whole human genome enrichment on dental calculus

KIRSTEN A. ZIESEMER<sup>1</sup>, JAZMIN RAMOS MADRIGAL<sup>2</sup>, ALLISON E. MANN<sup>3,4</sup>, KRITHIVASAN SANKARANARAYANAN<sup>5</sup>, CHRISTINA WARINNER<sup>3,4</sup>, CORINNE HOFMAN<sup>1</sup> and HANNES SCHROEDER<sup>1,2</sup>  
<sup>1</sup>Faculty of Archaeology, Leiden University, Leiden, the Netherlands, <sup>2</sup>Centre for Geogenetics, University of Copenhagen, Copenhagen, Denmark, <sup>3</sup>Max Planck Institute for the Science of Human History, Jena, Germany, <sup>4</sup>Department of Anthropology, University of Oklahoma, Norman, USA, <sup>5</sup>Department of Microbiology and Plant Biology, University of Oklahoma, Norman, USA

Most ancient DNA (aDNA) research focuses on bone and dentin, but host aDNA in these tissues is often poorly preserved. Recently, it was proposed that dental calculus (calcified dental plaque) may serve as an alternative source of host DNA in archaeological specimens. Investigations of ancient dental calculus have demonstrated that it is the richest known source of aDNA in the archaeological record. Although most of the genetic material within dental calculus is microbial in origin, it has been shown to contain sufficient mitochondrial DNA for full mitogenome reconstruction. Here, we explore whether dental calculus is also a viable substrate for whole human genome reconstruction by applying capture-enrichment and high-throughput DNA sequencing to twelve paired archaeological human dentin and dental calculus samples sourced from diverse temporal and geographical contexts. Shotgun sequencing of Illumina libraries yielded between 0.005 and 0.33% human DNA for the calculus samples and between 0.04 and 61.07% for the dentin samples. Whole genome capture led to significant enrichment in some cases but capture appears to be less efficient for samples below 1% or above 10% human endogenous DNA content based on low-coverage shotgun sequencing results. Based on these results it appears that while human dental calculus is an excellent source of microbial DNA, the human DNA content is relatively low compared to other substrates. However, targeted enrichment techniques can help increase the human DNA content and therefore maximise the amount of DNA sequence information that we can retrieve.

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### Using sociological segregation indices to reintroduce geographical relationships in anatomical skeletal collections

ADAM C.N. ZIMMER

Anthropology, University of Massachusetts Amherst

One of the main challenges in utilizing modern skeletal collections is the lack of geographical data. Researchers are often limited in their ability to study the remains in comparison to more spatially contextualized bioarchaeological samples. However, some collections such as the George Huntington Collection (1893-1921) are accompanied by documentary data that enable reconstructions of the lived environment. Reintroducing the lived environment enables researchers to more critically analyze these remains, rather than regarding them as merely pathological examples. This study created historical housing maps of New York City in ArcGIS to act as approximations of the socio-political surroundings individuals encountered in everyday life. Available documentary data was then used to resituate individuals within these maps. Sociological indices of housing segregation taken from the US Census Bureau were selected as independent variables. Indices used included Index of Dissimilarity, Index of Isolation, and Index of Interaction. Tukey's HSD tests were run on all possible pairwise group mean contrasts to assess the effect of each tract value's indices on the number of black individuals collected from that tract. Results indicate that African-American individuals in the Huntington Collection were taken at statistically significant ( $p < 0.05$ ) levels from those census tracts that were most economically and socially segregated. Findings suggest that biological anthropologists researching more recent urban skeletal collections may need to engage in transdisciplinary analyses in reconstructing lived experiences, particularly of marginalized communities.

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### Cranial integration is a major determinant of endocranial and brain shape

CHRISTOPH P.E. ZOLLIKOFER, THIBAUT BIENVENU and MARCIA S. PONCE DE LEÓN

Anthropological Institute and Museum, University of Zurich

The morphology of the endocranial cavity of hominid fossils is often used to infer the morphology of their long-gone brains, with the overarching goal to reconstruct evolutionary changes in brain size, organization, growth and development. While endocranial volume is a good proxy of brain volume, it is less clear to which extent endocranial shape reflects brain shape, and probably even brain organization, and

to which extent it is influenced by non-neural soft and hard tissue structures.

Here we address this question with a combined analysis of endocranial, basicranial and facial morphology in ontogenetic series of great apes and humans. A comparison of patterns of variation before and after the completion of brain growth permits to disentangle the mutual effects of the brain, base and face on each other's morphologies. Results indicate that endocranial shape is largely determined by the effects of cranial integration, specifically by the size relationship between the brain and the face+base. When these effects are taken into account, the remaining endocranial shape differences between humans and great apes reflect some, but not all, documented differences in brain organization.

The approach proposed here can also be applied to the endocranial morphology of our closest fossil relatives, the Neanderthals. Results indicate that major differences between human and Neanderthal endocranial morphologies are due to differences in facial+basicranial rather than brain morphology.

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### Mortuary Archaeology of the Pre-Columbian Aklis Site, St. Croix, USVI: Normativity and Deviance

MOLLY K. ZUCKERMAN<sup>2</sup>, DEREK T. ANDERSON<sup>1</sup>, D.S. MILLER<sup>2</sup>, JULIE FLORES<sup>3</sup>, SAVANNAH B. HUDSON<sup>4</sup>, GREGORY WEHRMAN<sup>5</sup> and MIKAYLA REDONA<sup>3</sup>

<sup>1</sup>Cobb Institute of Archaeology, Mississippi State University, <sup>2</sup>Anthropology and Middle Eastern Cultures, Mississippi State University, <sup>3</sup>Anthropology, San Diego State University, <sup>4</sup>Anthropology, University of Tulsa, <sup>5</sup>Anthropology, University of Tennessee

The Aklis site (12VAm1-42) is a coastal, multi-component habitation, cemetery, and shell midden site on St. Croix, USVI, which has been subject to early stage documentation, mitigation, and stabilization of exposed midden deposits and human remains since 2014. Excavations have yielded relatively complete burials (N=10) as well as multiple commingled remains (MNI=6). Aklis remains one of the largest prehistoric Ceramic age settlements on St. Croix, radiocarbon dated to AD 615 to AD 1950; artifacts recovered at the site and in association with the burials suggest no overlap with the contact period. Ceramic and lithic artifacts suggest that Aklis was inhabited by the Saladoid culture (400 BC - AD 600), characterized by tribal-level social organization and complex long distance trade networks, and the later Ostionoid culture (c. AD 1200 - AD 1400) of the Taíno, a chiefdom-level society with intensive agriculture. Little is known about prehistoric Caribbean mortuary archaeology, especially for these cultural phases, but burial positioning of

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those recovered from Aklis reveals substantial heterogeneity, with burials at the site attributed to these cultural phases ranging from single to commingled, flexed to likely bundled, and prone to supine. Unambiguous patterns in these positions are not preliminarily evident relative to age, sex or pathologies. Here, contextualizing these findings within existing work on Caribbean mortuary culture, and employing a biocultural and political economic framework, we explore whether this variability in mortuary culture fits within established regional cultural parameters or is indicative of the postmortem performance of normativity and deviance at the site.