

**Program of the 84<sup>th</sup> Annual Meeting of the  
American Association of Physical Anthropologists  
March 25-28, 2015**

To be held at the

**Hilton St. Louis at the Ballpark**

1 South Broadway  
St. Louis, MO 63102

**AAPA Scientific Program Committee:**

M. Anne Katzenberg, Chair

Abigail Bigham	Terry Ritzman
John Krigbaum	Masako Fujita
Carola Borries	Mary Silcox
Sang-Hee Lee	Tracey Galloway
Richard Brisbescas	Julie Teichroebe
Kristi Lewton	Lauren Halenar
Scott Burnett	Claire Terhune
Ripan Malhi	Katarina Harvati
Michelle Buzon	Christina Torres-Rouff
Andrew Marshall	Laurie Kauffman
David Cooper	Frank Williams
Charles Musiba	Corina Kellner
Susanne Cote	Amy Rector Verrelli
Herman Pontzer	Dan Eisenberg

Nicole Engel, Program Assistant

**Local Arrangements Committee**

Washington University

E.A. Quinn, chair

Libby Cowgill	Amanda Melin
Lisa Kelley	Michael Montague
Sarah Lacy	David Morgan
LeAndra Luecke	Charles Roseman
Katherine MacKinnon	Crickette Sanz

## Message from the Program Chair

Welcome to the 84<sup>th</sup> Annual Meeting of the American Association of Physical Anthropologists in St. Louis 2015!

Our meeting officially begins on Wednesday, March 25 with the **Undergraduate Research symposium**, followed by the **AAPA welcoming reception**. Also on Wednesday, the Committee on Diversity is offering two **Women's Mentoring Workshops**. Based on members' feedback and the success of last year's Thursday afternoon Plenary Poster session, we are having dedicated time for posters from 4:00 to 6:00, so that everyone will have time to participate in the poster sessions. The time of day is ideal for an "enhanced" afternoon break at 4:00. Posters will be up all day, as in the past, but there will be no concurrent podium sessions after 4:00.

As in the past two years, the **AAPA annual business meeting** will be held after the scientific sessions on Friday afternoon beginning at 5:45. A highlight of this meeting is the presentation of the **Charles R. Darwin Lifetime Achievement Award and the Gabriel W. Lasker Service Award**. Please come to learn more about the AAPA and to celebrate the careers of this year's honorees. The **AAPA Annual Luncheon** will once again be on Saturday and features Dr. Nina Jablonski speaking on "Skin Pigmentation is Relevant to everything that Physical Anthropologists Aspire to Do". See the Local Arrangements web site for tickets and information.

This year's program includes 1065 scientific presentations over the three full days of the meeting. The 60 sessions include six invited podium symposia, 14 invited poster symposia, 21 contributed podium sessions and 19 contributed poster sessions. Dedicated time for posters has resulted in shorter afternoon podium sessions, so we added a fifth podium session on Friday morning only, with four concurrent podium sessions on other days.

Our extensive scientific program includes a truly international group of scholars. We are joined by the *Paleopathology Association* (PPA), the *Human Biology Association* (HBA) and the *American Association of Anthropological Genetics* (AAAG).

The joint AAPA – HBA session, held on Friday morning, is an invited poster symposium titled: **Multi-generational Perspectives on Human Biology and Anthropological Genetics: A Symposium in Honor of Michael H. Crawford**, and organized by William Leonard and Dennis O'Rourke. The joint AAPA-AAAG session, held on Saturday morning, is an invited podium symposium titled: **Rethinking Racial Health Disparities: The genetic anthropologists' contribution to debates over health inequalities**, organized by Abigail Bigham and Amy Non. The Wiley-Blackwell symposium, **Energetics in Human and Non-Human Primate Evolution: Moving from Theory to Empirical Tests**, organized by Christopher Kuzawa and Herman Pontzer, is on Thursday morning. **The AAPA silent and live auctions** take place on Thursday evening. These auctions, started by Mark Teaford and continued by Susan Antón, have raised thousands of dollars that fund the Pollitzer Student Travel Awards. Please participate through donations and bidding. An enhanced **Closing Reception and Student Awards Ceremony** will be held on Saturday evening.

The AAPA **Committee on Diversity** is offering a **Panel Discussion** on Saturday afternoon titled "In the Shadow of Ferguson – Race, Inequality and how Biological Anthropologists might contribute to the Dialog".

I am very grateful to all those who have helped to put the 2015 program together. First and foremost, webmaster Ed Hagen, designer and upgrader of our on-line system has patiently guided me through the entire process of receiving abstracts, registrations, receiving reviews and assembling the meeting issue. Susan Antón has offered her wisdom as previous AAPA VP, as have other members of the Executive. As Susan has pointed out, it literally takes a village. Thanks to the members of the Program Committee for their careful work. Special thanks to EA Quinn and her local arrangements committee. Please express your appreciation when you meet them in St. Louis.

Anne Katzenberg  
AAPA Vice President and Program Chair

## Contents

Message from the Program Committee Chair	2
Floor Plans	4
Conference Schedule Day-By-Day	5
AAPA Presentation Schedule	10
Author/Session Index	52
Abstracts of the AAPA presentations	65

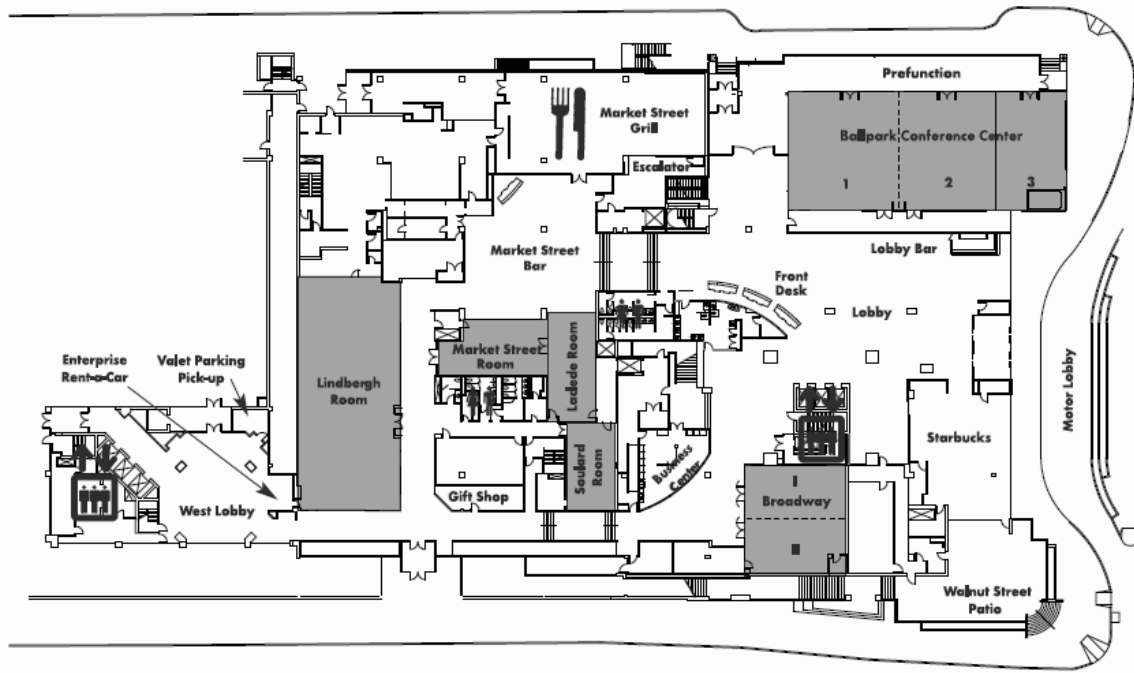
On the cover: The St. Louis Arch

Supplement was mailed the week of February 23, 2015

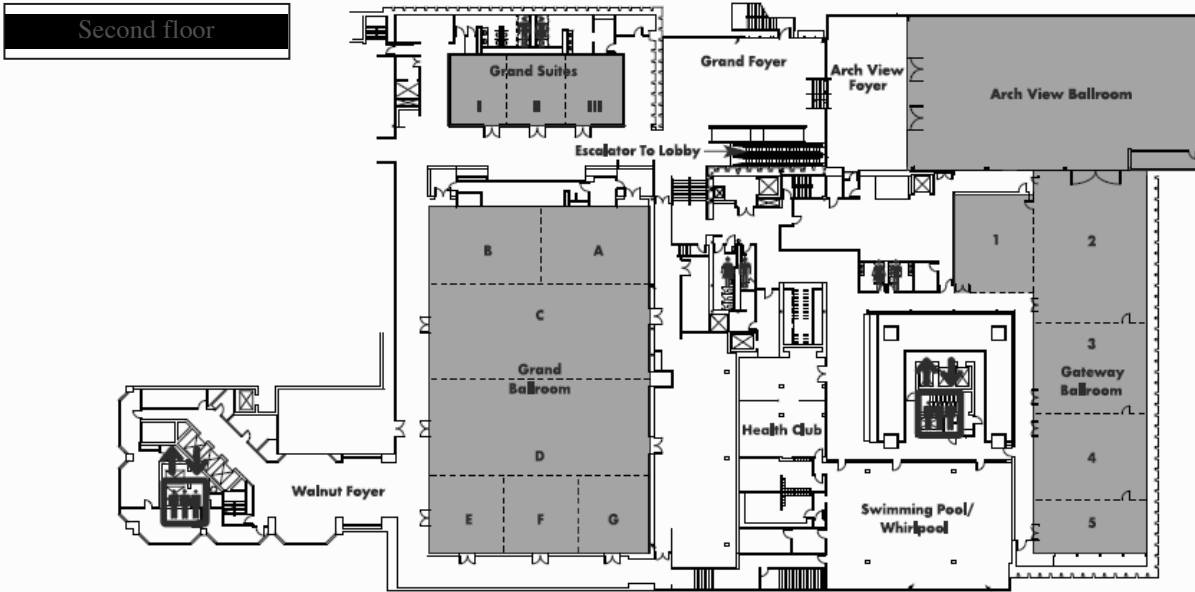
### KEY TO ACRONYMS:

<p><b>AAAG</b> – American Association of Anthropological Genetics  <b>AAPA</b> – American Association of Physical Anthropologists  <b>ADA</b> – American Dermatoglyphics Association  <b>AJHB</b> – <i>American Journal of Human Biology</i>  <b>AJPA</b> – <i>American Journal of Physical Anthropology</i>  <b>BANDIT</b> Biological Anthropology Developing Investigators Troop  <b>COD</b> – AAPA’s Committee on Diversity  <b>DAA</b> – Dental Anthropology Association  <b>HB</b> – <i>Human Biology</i>  <b>HBA</b> – Human Biology Association  <b>JHE</b> – <i>Journal of Human Evolution</i>  <b>PAWMN</b> AAPA Physical Anthropology Women’s Mentoring Network  <b>PPA</b> – Paleopathology Association</p>
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### Lobby Level



### Meeting Rooms



Manchester Room – 4<sup>th</sup> Floor, West Tower

**Monday Evening****Paleopathology Association**

Paleopathology Association Registration	Hilton Lobby	6:00 p.m.-9:00 p.m.
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**Tuesday**

Family Respite Room	Soulard	7:30 a.m.-10 p.m.
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**Human Biology Association**

Human Biology Association Registration	Ballpark Registration Desk	5 p.m.-8 p.m.
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**Paleopathology Association**

Paleopathology Association Registration	Gateway Foyer	7:45 a.m.-5 p.m.
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Paleopathology Association Workshop I	Grand Suites 2/3	8:30 a.m.-11 a.m.
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Paleopathology Association Workshop II	Gateway Ballroom 1	8:30 a.m.-11:25 a.m.
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Paleopathology Association Special Presentation	Gateway Ballroom 2	11:30 a.m.-noon
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Paleopathology Association Podium Presentations	Gateway Ballrooms 1/2	1:30 p.m.-5 p.m.
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Paleopathology Association Student Action Meeting	Grand Suite 3	5 p.m.-6:30 p.m.
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Paleopathology Association Banquet	Lindbergh	6:45 p.m.-10 p.m.
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**Wednesday Morning****AAPA**

AAPA Committee on Diversity Women's Mentoring Workshop	Manchester	8:30 a.m.-noon
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**Human Biology Association**

AJHB Editorial Board Breakfast	Market Street Room	7:30 a.m.-9 a.m.
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Human Biology Assoc. Breakout Session 1	Grand Suite II	11:30 a.m.-12:30 pm
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Human Biology Assoc. Breakout Session 2	Grand Suite III	11:30 a.m.-12:30 pm
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Human Biology Association Posters	Archview Ballroom	8 a.m.-11 a.m.
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Human Biology Association Registration	Ballpark Registration Desk	8 a.m.-10 a.m.
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**Paleopathology Association**

Paleopathology Association Registration	Gateway Foyer	8 a.m.-noon
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**Wednesday All day****AAPA**

Family Respite Room	Soulard	7:30 a.m.-11 p.m.
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AAPA Executive Committee Meeting	Laclede	8 a.m.-5 p.m.
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**Dental Anthropology Association**

Dental Anthropology Workshop	Broadway 2	8 a.m.-5 p.m.
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**Paleopathology Association**

Paleopathology Association Podium Presentations	Ballpark 1/2	8 a.m.-5 p.m.
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Paleopathology Association Poster Presentations	Archview Ballroom	9 a.m.-4 p.m.
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**Wednesday Afternoon****AAPA**

AJPA Editorial Board Lunch	Market Street Room	noon-2 p.m.
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Human Biology Association Plenary Session	Gateway Ballrooms 4/5	1 p.m.-6 p.m.
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AAPA Committee on Diversity Women's Mentoring Workshop	Manchester	1:30 p.m.-5 p.m.
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AAPA Registration	Grand Foyer	4 p.m.- 8 p.m.
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AAPA Student Committee Panel: Networking	Grand Suites 2	4 p.m.-5 p.m.
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## Day-By-Day

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### Dental Anthropology Association

Dental Anthropology Working Group                      Ballpark 3                      5 p.m.-6 p.m.

### **Wednesday Evening**

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#### AAPA

**AAPA Committee on Diversity: Undergraduate Research Symposium and Reception**                      Archview Foyer                      5:30 p.m.-8 p.m.  
(5:00 set-up, closed reception 5:30 – 6:00; open to all 6:00)

**AAPA Welcome Reception**                      Grand Ballroom                      8 p.m.-11 p.m.

### Dental Anthropology Association

Dental Anthropology Working Group                      Ballpark 3                      5 p.m.-6 p.m.

### Human Biology Association

Human Biology Association Dinner                      Lindbergh                      6:30 p.m.-9:30 p.m.

### **Thursday Morning**

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#### AAPA

ENERGETICS IN HUMAN AND NON-HUMAN PRIMATE EVOLUTION: MOVING FROM THEORY TO EMPIRICAL TESTS                      Grand Ballroom D                      8 a.m.-noon                      1                      Invited Podium  
*Wiley-Blackwell Symposium*

VARIATION AND POPULATION GENETICS: non-human studies                      Grand Ballroom A/B                      8 a.m.-noon                      2                      Podium

SKELETAL BIOLOGY: Paleopathology                      Grand Ballroom C                      8 a.m.-noon                      3                      Podium

PRIMATE BEHAVIOR                      Grand Ballroom E/F/G                      8 a.m.-noon                      4                      Podium

THINKING ANTHROPOLOGICALLY ABOUT GENETICS                      Gateway Ballroom 2                      8 a.m.-noon                      5                      Invited Poster

CAHOKIA: BIOLOGICAL EVIDENCE OF IMPACTS AND INTERACTIONS                      Gateway Ballroom 3                      8 a.m.-noon                      6                      Invited Poster

INTER-INDIVIDUAL DIFFERENCES IN COLLECTIVE ACTION                      Gateway Ballroom 4                      8 a.m.-noon                      7                      Invited Poster

#### Human Biology Association

Human Biology Association Registration                      Ballpark Registration Desk                      8 a.m.-10 a.m.

Human Biology Association Podium Presentations                      Ballpark 1/2                      8:30 a.m.-11:45 a.m.

### **Thursday All day**

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#### AAPA

AAPA Registration                      Grand Foyer                      7:30 a.m.-5 p.m.

Press and Interview Room                      Laclede                      7:30 a.m.-5 p.m.

Family Respite Room                      Soulard                      7:30 a.m.-10 p.m.

Exhibitors                      Gateway Ballroom 1                      8 a.m.-5 p.m.

PALEOANTHROPOLOGY: Primate evolution                      Archview Ballroom                      8 a.m.-6 p.m.                      8                      Poster

BIOARCHAEOLOGY                      Archview Ballroom                      8 a.m.-6 p.m.                      9                      Poster

SKELETAL BIOLOGY: Paleopathology and Violence                      Archview Ballroom                      8 a.m.-6 p.m.                      10                      Poster

DENTAL ANTHROPOLOGY: Human and Non-human Primates                      Archview Ballroom                      8 a.m.-6 p.m.                      11                      Poster

PRIMATOLOGY: Life History                      Archview Ballroom                      8 a.m.-6 p.m.                      12                      Poster

ANTHROPOLOGICAL GENETICS                      Archview Ballroom                      8 a.m.-6 p.m.                      13                      Poster

BIOARCHAEOLOGY: Growth, Nutrition and Health                      Archview Ballroom                      8 a.m.-6 p.m.                      14                      Poster

### **Thursday Afternoon**

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#### AAPA

COD Committee Meeting                      Grand Suites 2                      noon-1 p.m.

*Yearbook of Physical Anthropology* Editorial Board Meeting                      Market Street Room                      noon-2 p.m.

AAPA PA WMN Lunch (reservations required)                      Broadway                      11:45 a.m.-1:45 p.m.

Day-By-Day

COSTLY AND CUTE: HOW HELPLESS NEWBORNS MADE US HUMAN	Grand Ballroom D	1 p.m.-4:15 p.m.	15	Invited Podium
PALEOANTHROPOLOGY: Early hominin evolution	Grand Ballroom C	1 p.m.-4 p.m.	16	Podium
SKELETAL BIOLOGY: Functional morphology	Grand Ballroom E/F/G	1 p.m.-4 p.m.	17	Podium
GENETICS: Human variation	Lindbergh	1 p.m.-4 p.m.	18	Podium
BODY MASS ESTIMATION IN BIOLOGICAL ANTHROPOLOGY	Gateway Ballroom 2	1 p.m.-5 p.m.	19	Invited Poster
THE BIOARCHAEOLOGY OF CARDIOVASCULAR DISEASE	Gateway Ballroom 3	1 p.m.-5 p.m.	20	Invited Poster
BEYOND THE BONES: ENGAGING WITH DISPARATE DATASETS	Gateway Ballroom 4	1 p.m.-5 p.m.	21	Invited Poster

**Human Biology Association**

Human Biology Association Podium Presentations	Ballpark 1/2	1:30 p.m.-4:30 p.m.		
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**Thursday Evening**

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**AAAA**

AAAA Auction - Silent 4:30 - 7:00; Live 7:00 - 9:30 (benefits student travel)	Grand Ballroom A/B	4:30 p.m.-10 p.m.		
AAAA PA WMN Happy Hour	Broadway	5 p.m.-6:30 p.m.		
AAAG Network Event (pre-registration required)	Market Street Room	5 p.m.-6:30 p.m.		
AAAA COD LGBTQQIAA Interest Group	Grand Suites 2	6 p.m.-8 p.m.		
AAAA COD AACT Teaching Bioanthropology in the 21st Century	Manchester	6 p.m.-9 p.m.		
<b>Wiley Reception</b>	Gateway Foyer	8 p.m.-10 p.m.		

**Human Biology Association**

Human Biology Association Annual Business Meeting	Ballpark 1/2	5 p.m.-6:30 p.m.		
Human Biology Association Student Reception (members only)	Ballpark 3	7 p.m.-9:30 p.m.		

**Friday Morning**

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**AAAA**

NSF One-on-One's (contact RFERRELL@nsf.gov)	Grand Suites 2	10 a.m.-11:30 a.m.		
Filling the Geographic Gaps in the Human Evolutionary Story	Grand Ballroom D	8 a.m.-noon	22	Invited Podium
Functional Morphology: Non-human	Grand Ballroom A/B	8 a.m.-noon	23	Podium
Bioarchaeology: Diet and Demography	Grand Ballroom C	8 a.m.-noon	24	Podium
Primate Evolution	Grand Ballroom E/F/G	8 a.m.-noon	25	Podium
Primate Behavior	Lindbergh	8 a.m.-noon	26	Podium

**AAAA- Human Biology Association Symposium**

Multi-generational Perspectives on Human Biology and Anthropological Genetics: A Symposium in Honor of Michael H. Crawford	Gateway Ballroom 2	8 a.m.-noon	27	Invited Poster
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**AAAA**

Kampsville: Celebrating Six Decades of Anthropological Research	Gateway Ballroom 3	8 a.m.-noon	28	Invited Poster
Females: Friends or Foes? New Perspectives on Female Bonds in Primates	Gateway Ballroom 4	8 a.m.-noon	29	Invited Poster

**Other**

Publisher's Workshop	Manchester	10 a.m.-noon		
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**Friday All day**

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**AAAA**

AAAA Registration	Gateway Foyer	7:30 a.m.-5 p.m.		
Press and Interview Room	Laclede	7:30 a.m.-5 p.m.		

## Day-By-Day

Family Respite Room	Soulard	7:30 a.m.-10 p.m.	
Exhibitors	Gateway Ballroom 1	8 a.m.-5 p.m.	
Fossil Cast Comparison and Video Room	Grand Suite 3	8 a.m.-5 p.m.	
Paleoanthropology: Hominins and Early Homo	Archview Ballroom	8 a.m.-6 p.m.	30 Poster
Functional Skeletal Biology: Non-human Studies	Archview Ballroom	8 a.m.-6 p.m.	31 Poster
Functional Skeletal Biology: Human Studies	Archview Ballroom	8 a.m.-6 p.m.	32 Poster
Primatology: Behaviour	Archview Ballroom	8 a.m.-6 p.m.	33 Poster
Human Biology	Archview Ballroom	8 a.m.-6 p.m.	34 Poster
Paleoanthropology: Late Homo	Archview Ballroom	8 a.m.-6 p.m.	35 Poster

**Friday Afternoon****AAAA**

AAAA Ethics Committee	Ballpark 1	12 p.m.-2 p.m.	
NSF Conversation Hour	Grand Suites 2	2 p.m.-3 p.m.	
AAAA COD Panel	Market Street Room	2 p.m.-4 p.m.	
AAAA Career Development Panel	Manchester	12 p.m.-2 p.m.	
The Last Link: Tarsiers	Grand Ballroom D	1 p.m.-4:15 p.m.	36 Invited Podium
Human Biology: Reproduction, health and disease	Grand Ballroom A/B	1 p.m.-4 p.m.	37 Podium
Skeletal Biology: Growth and Development	Grand Ballroom C	1 p.m.-4 p.m.	38 Podium
Paleoanthropology: Genus Homo	Grand Ballroom E/F/G	1 p.m.-4 p.m.	39 Podium
Forensic and bioarchaeological perspectives on biological distance	Gateway Ballroom 2	1 p.m.-5 p.m.	40 Invited Poster
Embodying Impairment: Towards a Bioarchaeology of Disability	Gateway Ballroom 3	1 p.m.-5 p.m.	41 Invited Poster
Contributions in honor of Tab Rasmussen	Gateway Ballroom 4	1 p.m.-4 p.m.	42 Special Poster
BANDIT (Biological Anthropology Developing Investigators Troop)	Off-site, TBD	4 p.m.-6 p.m.	

**Friday Evening****AAAA**

<b>AAAA Business Meeting and Lifetime Awards</b>	Grand Ballroom A/B	5:45 p.m.-7:45 p.m.	
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**AAAG**

AAAG Business Meeting and Reception	Ballpark 1/2	7 p.m.-9 p.m.	
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**Dental Anthropology Association**

Dental Anthropology Association Business Meeting	Manchester	7 p.m.-8 p.m.	
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**Other Organizations**

<i>Human Biology</i> Editorial Board Meeting	Ballpark 3	7 p.m.-10 p.m.	
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American Dermatoglyphics Association Business Meeting	Lindbergh	7 p.m.-9 p.m.	
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<i>Journal of Human Evolution</i> Editorial Board Meeting	Market Street Room	7 p.m.-9 p.m.	
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**Saturday Morning****AAAA**

NSF One-on-One's (contact RFERRELL@nsf.gov)	Grand Suites 2	10 a.m.-11:30 a.m.	
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The future of the Middle Pleistocene: New evidence from the Sima de los Huesos (Sierra de Atapuerca, Spain)	Grand Ballroom C	8 a.m.-noon	43 Invited Podium
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**AAAA-AAAG Symposium**

Rethinking Racial Health Disparities: The genetic anthropologist's contribution to debates over health inequalities	Grand Ballroom D	8 a.m.-noon	44 Invited Podium
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**AAAA**



## Day-By-Day

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Primateology: Ecology and Conservation podium	Grand Ballroom A/B	8 a.m.-11:15 a.m.	45	Podium
Paleoneurology	Grand Ballroom A/B	11:15 a.m.-noon	46	Podium
Human Biology: Adaptation	Grand Ballroom E/F/G	8 a.m.-10 a.m.	47	Podium
Skeletal Biology: Dentition and Diet	Grand Ballroom E/F/G	10:15 a.m.-noon	48	Podium
Engaging Research Communities: Collaborating and Translating Research in Biological Anthropology	Archview Ballroom	8 a.m.-noon	49	Invited Poster
Triumphs and Tribulations in Teaching	Archview Ballroom	8 a.m.-noon	50	Invited Poster
Broader Impacts: Effective Education and Public Outreach in Physical Anthropology	Archview Ballroom	8 a.m.-noon	51	Invited Poster

### **Saturday All day**

#### **AAPA**

AAPA Registration	Grand Foyer	7:30 a.m.-5 p.m.		
Press and Interview Room	Laclede	7:30 a.m.-5 p.m.		
Family Respite Room	Soulard	7:30 a.m.-10 p.m.		
Exhibitors	Gateway Ballroom 1	8 a.m.-5 p.m.		
Primateology: Ecology and Conservation	Gateway Ballroom 2/3/4/5	8 a.m.-6 p.m.	52	Poster
Forensic anthropology and taphonomy	Gateway Ballroom 2/3/4/5	8 a.m.-6 p.m.	53	Poster
Nutrition, Health and Disease	Gateway Ballroom 2/3/4/5	8 a.m.-6 p.m.	54	Poster
Skeletal Biology: Growth and Development	Gateway Ballroom 2/3/4/5	8 a.m.-6 p.m.	55	Poster
Paleoanthropology: Taphonomy, Taxonomy and Methods	Gateway Ballroom 2/3/4/5	8 a.m.-6 p.m.	56	Poster

### **Saturday Afternoon**

#### **AAPA**

<b>AAPA Luncheon</b> - Dr. Nina Jablonski "Skin Pigmentation is Relevant to Everything that Physical Anthropologists Aspire to Do"	Lindbergh	noon-2 p.m.		
AAPA Education Committee: K-12 Teacher Training Workshop	Manchester	1 p.m.-4:30 p.m.		
AAPA COD Panel: "In the Shadow of Ferguson - Race, Inequality and how Biological Anthropologists might Contribute to the Dialog"	Grand Suites 2/3	2 p.m.-4 p.m.		
Paleoanthropology: Hominins, taxonomy and taphonomy	Ballpark 1/2	2 p.m.-5 p.m.	57	Podium
Human Biology	Broadway	2 p.m.-5 p.m.	58	Podium
Skeletal Biology: Demography and Forensic Anthropology	Grand Ballroom A/B	2 p.m.-5 p.m.	59	Podium
Primateology: Life History	Grand Ballroom E/F/G	2 p.m.-5 p.m.	60	Podium

### **Saturday Evening**

#### **AAPA**

<b>AAPA Closing Reception and Student Awards</b>	Ballpark Conference Center	6 p.m.-9 p.m.		
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## Thursday, March 26, 2015 - Morning sessions.

### Session 1: **Energetics in Human and Non-Human Primate Evolution: Moving from Theory to Empirical Tests**

*The Wiley-Blackwell Invited Podium Symposium.* Chair: Christopher Kuzawa

Co-organizer: Herman Pontzer

#### **Grand Ballroom D**

The remarkable diversity in primate life histories reflects differences in the quantity of energy and metabolic resources available within the body, and the priority with which energy is allocated across the key functions of growth, reproduction, activity and maintenance. Energetics lies at the heart of questions cutting across the subfields of Biological Anthropology: How do ecological pressures such as climate and foraging effort affect energy throughput? When and how does energy expended on activity, thermoregulation, immune function, or other tasks affect the pace of growth, reproduction, and aging? What are the constraints on energy allocation and how have these shaped the evolution of life cycles? How does the body manage acute trade-offs between competing functions, and what are the implications for phenotypic diversity within and across populations? What are the social dimensions of energy flow and what are their roles in reproductive strategies? Recent methodological advances have enabled anthropologists to move beyond simple models of energy expenditure to empirical tests of energy allocation in humans and other primates, from the lab to the field, and even in skeletal and fossil remains. This session will bring human biologists, paleoanthropologists and primatologists together to explore the role of energetics in the evolution of human and non-human primates.

- 8:00 The evolutionary history of hominin growth, life history, and energetics. G.T. SCHWARTZ.
- 8:15 Hard Tissues maintain a record of whole body metabolism and enlighten the metabolomics of development and life history. T.G. BROMAGE, R.T. HOGG, R.S. LACRUZ, T.D. CRENSHAW, F. SCHRENK.
- 8:30 Brain growth, energetics, and the slow life history of Neanderthals. C.P. ZOLLIKOFER, M.S. PONCE DE LEÓN.
- 8:45 Humans, the high-energy ape: hominoid energetics and life history evolution. H. PONTZER, M.H. BROWN, H.M. DUNSWORTH, S.R. ROSS.
- 9:00 The high metabolic costs of human brain development help explain the unusually slow body growth of human childhood. C. KUZAWA, H.T. CHUGANI, L.I. GROSSMAN, L. LIPOVICH, O. MUZIK, P.R. HOF, D.E. WILDMAN, C.C. SHERWOOD, W.R. LEONARD, N. LANGE.
- 9:15 Differences in energy metabolism in the brains of humans and chimpanzees: a study of protein expression. A.L. BAUERNFEIND, M.L. REYZER, R.M. CAPRIOLI, J.J. ELY, C.C. BABBITT, G.A. WRAY, P.R. HOF, C.C. SHERWOOD.
- 9:30 How evolutionary changes in human life histories affect juvenile energetics. K.L. KRAMER.
- 9:45 Placentergetics: exploring placental investment in fetal somatic and brain development. J. RUTHERFORD, V. DEMARTELLY, K. PHILLIPS, M. LAMAR.
- 10:00 *Break*
- 10:15 Life history trade-offs as a function of mother's milk: Consequences for juvenility and transitions to adulthood. K. HINDE, J.P. CAPITANIO.
- 10:30 Tradeoffs between reproductive rate and offspring growth in wild chimpanzees. M. EMERY THOMPSON, Z.P. MACHANDA, N. BRAZEAU, M.N. MULLER, R.W. WRANGHAM.
- 10:45 Coping with a challenging environment: nutritional balancing, health, and energetics in wild Bornean orangutans. E.R. VOGEL, J.M. ROTHMAN, A.M. MOLDAWER, T.D. BRANSFORD, M.E. EMERY-THOMPSON, M.A. VAN NOORDWIJK, S. UTAMI ATMOKO, B.E. CROWLEY, C.D. KNOTT, W.M. ERB, D. RAUBENHEIMER.
- 11:00 Contributions of brown adipose tissue to human metabolic adaptation: Comparative and evolutionary perspectives. W.R. LEONARD, S.B. LEVY.
- 11:15 Metabolic and endocrine changes during immune activation. M.P. MUEHLENBEIN.
- 11:30 Energetic costs of testosterone: higher testosterone is associated with greater lean muscle mass and total energetic expenditure among Tsimane forager-horticulturalists. B.C. TRUMBLE, D. CUMMINGS, B. BEHEIM, J. STIEGLITZ, G. YETISH, H. PONTZER, H. KAPLAN, M. GURVEN.
- 11:45 Discussion: Peter Ellison, Harvard University.

### Session 2: **Variation and population genetics: non-human**

*Contributed Podium Presentations.* Chair: Jessica Brinkworth

#### **Grand Ballroom A/B**

- 8:00 Phylogenetic relationships of Night Monkeys (*Aotus*): Evidence from pelage coloration and molecular data. F.M. CORNEJO, V.R. PACHECO, L. CORTÉS ORTIZ.
- 8:15 ~~A Comprehensive Genus Level Primate Phylogeny Using Gene Tree Species Tree Reconciliation.~~ L.C. MATTHEWS, L. POZZI.
- 8:30 Neotropical primate biogeography: A synthesis. J.W. LYNCH ALFARO, L. CORTÉS-ORTIZ, A. DI FIORE, J.P. BOUBLI.

## Thursday Morning Sessions

- 8:45 The potential role of nonadaptive evolutionary mechanisms shaping color vision in red-bellied lemurs (*Eulemur rubriventer*). R.L. JACOBS, B.J. BRADLEY.
- 9:00 The role of genetic correlation in papionin facial evolution. J.L. JOGANIC, F.B. DE OLIVEIRA, K.E. WILLMORE, J.T. RICHTSMEIER, J. ROGERS, J.M. CHEVERUD.
- 9:15 Central and eastern chimpanzees are characterized by clinal genetic variation rather than a distant subspecies break. T. FÜNFSTÜCK, M. ARANDJELOVIC, D.B. MORGAN, C. SANZ, P. REED, S.H. OLSON, K. CAMERON, A. ONDZIE, M. PEETERS, L. VIGILANT.
- 9:30 Structural variant discovery among related vervet monkeys. M.J. MONTAGUE, L. HILLIER, A.J. JASINSKA, T. TURNER, J. KAPLAN, M.J. JORGENSEN, N. FREIMER, G. WEINSTOCK, R.K. WILSON, W.C. WARREN.
- 9:45 Maternal effects influence the heritability of adult obesity traits but not obesogenic growth trajectories in vervet monkeys (*Chlorocebus* spp.). C.A. SCHMITT, S.K. SERVICE, R.M. CANTOR, A.J. JASINSKA, M.J. JORGENSEN, J.R. KAPLAN, N.B. FREIMER.
- 10:00 *Break*
- 10:15 Diet-microbe co-metabolic interactions in wild primates reveal clues on human evolution. A.M. GOMEZ, J.M. ROTHMAN, K. PETRZELKOVA, C.J. YEOMAN, K. VLCKOVA, J.D. UMANA, M. CARR, D. MODRY, A. TOD, K. NELSON, R.M. STUMPF, B.A. WILSON, B.A. WHITE, S.R. LEIGH.
- 10:30 Autosomal admixture in natural and anthropogenic hybrids of two species of eastern Brazilian marmosets (*Callithrix jacchus* and *C. penicillata*). J. MALUKIEWICZ, V. BOERE, A.D. GRATIVOL, I.O. SILVA, L.C. PEREIRA, C.R. RUIZ-MIRANDA, A.C. STONE.
- 10:45 Evolution of primate early genomic responses to severe infection. J.F. BRINKWORTH, J. KOHN, R.E. LANFORD, Z.P. JOHNSON, L.B. BARREIRO.
- 11:00 High-throughput restriction site associated DNA sequencing (RAD-Seq) for genomic studies of primates using museum specimens. A.S. BURRELL, T.R. DISOTELL, S. HAUEISEN, C.M. BERGEY.
- 11:15 Genomic analysis of pre-Columbian tuberculosis from the New World. K.M. HARKINS, K.I. BOS, A. HERBIG, M. COSCOLLA, J.E. BUIKSTRA, S. GAGNEUX, J. KRAUSE, A.C. STONE.
- 11:30 Ancient wolf genome reveals gene flow with domestic dogs. P. SKOGLUND, E. ERSMARK, E. PALKOPOULOU, D. REICH, L. DALÉN.
- 11:45 Using Ancient DNA to Discover the True Domestication Origins of South American Camelids. A.M. DIAZ LAMEIRO, D. MERRIWETHER.

**Session 3: Skeletal Biology: Paleopathology**

*Contributed Podium Presentations.* Chair: Laurie J. Reitsema

**Grand Ballroom C.**

- 8:00 Creating a Standardized Methodology for Recording Trauma in Human Skeletal Remains. R.A. CAMPBELL.
- 8:15 Adapt or die: three case studies in which the failure to adopt advances from other fields has compromised paleopathology. M.K. ZUCKERMAN, K.N. HARPER, G.J. ARMELAGOS.
- 8:30 Biological Distance of the Effigy Mound Phenomenon in Southern Wisconsin: A Complementary Approach to Understanding Social Organization. J.B. CORNELISON.
- 8:45 Dietary patterns in archaeological populations from Northern Chile revealed by isotopic analyses. S.V. FLORES, F.A. SANTANA, T.B. GONZALEZ, M.I. URIBE.
- 9:00 "Race Becomes Biology": Co-occurring Oral and Systemic Disease Processes as Embodiment of Structural Violence in Skeletal Remains. R.G. GENGO.
- 9:15 Changing Perspectives on Social Relations at Neolithic Çatalhöyük: Evidence from Cranial Trauma. B.A. GLENCROSS, C.J. KNÜSEL.
- 9:30 Tending the Vines: Biomechanical Evidence of Laterality and Gendered Labor Division in Viticulture at Pessinus, Turkey. L. WILLIAMS, J. MASSÉGLIA.
- 9:45 Decoration and cremation of neolithic human bones from Göbekli Tepe, Turkey. J. GRESKY.
- 10:00 *Break.*
- 10:15 The prevalence of caries in Bronze Age populations from the Northern Caucasus. K. FUCHS, J. GRESKY.
- 10:30 Comparative Perspectives on Subadult Dietary Variation in North-Central Poland, 10-19<sup>th</sup> c. AD. L.J. REITSEMA, M. KRAJEWSKA, T. KOZŁOWSKI.
- 10:45 Investigation of Nonspecific Stress Indicators in Middle and Older Female Adults from Rural and Urban Post-Medieval London. A. PERRONE.
- 11:00 Skeletal diagnosis of multiple diseases in an European juvenile. S. IOANNOU, M. HENNEBERG, R.J. HENNEBERG, T. ANSON.
- 11:15 Comparative morphology and molecular genetic analysis of patterns of syphilis of archaeological human remains from museum collections. R.I. TUKHBATOVA, A.P. BUZHILOVA, A.V. RASSKAZOVA, O.A. KRAVTSOVA, V.I. KHARTANOVICH, N.Y. BEREZINA.
- 11:30 Chest wall tuberculous abscess: a rare and challenging diagnosis on past human skeletal remains. V.M. MATOS, C. MARQUES, F. CURATE, C. LOPES.

**Session 4: Primate Behavior***Contributed Podium Presentations.* Chair: Amanda Melin**Grand Ballroom E/F/G.**

- 8:00 Muscle functional morphology of comparative primate locomotor modes: Implications for the study of human fossils. C.M. TURCOTTE, J. POTAU, R. DIOGO.
- 8:15 Lateralization and Performance Asymmetries in the Termite Fishing of Wild Chimpanzees in the Goulougo Triangle, Republic of Congo. C.M. SANZ, D. MORGAN, W. HOPKINS.
- 8:30 Behavioral flexibility in orangutans: How sociality is modulated at different levels by fruit availability, demographics, and life history in a wild population on Borneo. C.A. O'CONNELL, C.D. KNOTT.
- 8:45 Examining the links among fruit signals, nutritional value, and the sensory behaviors of wild capuchin monkeys (*Cebus capucinus*). A.D. MELIN, M. SHIRASU, Y. MATSUSHITA, M.S. MYERS, M.L. BERGSTROM, V. VENKATARAMAN, J.M. ROTHMAN, L.M. FEDIGAN, K. TOUHARA, S. KAWAMURA.
- 9:00 Intergroup variation in estrogenic plant consumption for the black-and-white colobus monkey of Kibale National Park, Uganda. K.M. BENAVIDEZ, T.R. HARRIS, M.D. WASSERMAN, C.A. CHAPMAN, D.C. LEITMAN, J. ROTHMAN.
- 9:15 Unpacking proximate mechanisms of cooperation: The role of oxytocin and other hormones in meat sharing among Tsimane' hunters. A.V. JAEGGI, B.C. TRUMBLE, H.S. KAPLAN, M. GURVEN.
- 9:30 The adaptive value of male relationships in the chimpanzees of Gombe National Park, Tanzania. J.T. FELDBLUM, C. KRUPENYE, E.E. WROBLEWSKI, R.S. RUDICELL, B.H. HAHN, A.E. PUSEY, I.C. GILBY.
- 9:45 Prey Switching by Chimpanzees at Ngogo, Kibale National Park. D.P. WATTS, J.C. MITANI.
- 10:00 Break.
- 10:15 The evolution of subordination and social complexity: an analysis of power in Verreaux's sifaka. R.J. LEWIS.
- 10:30 The Influence of Fighting Ability and Reproduction in Intersexual Relationships in Verreaux's Sifaka (*Propithecus verreauxi*). K.M. ORTIZ, R.J. LEWIS.
- 10:45 Rate of agonism may be the only useful predictor of despotic dominance hierarchies. A. KOENIG, C.J. SCARRY, B.C. WHEELER, C. BORRIES.
- 11:00 Alternative routes to reproductive success may explain male cooperation in a primate population (*Cebus capucinus*) with high reproductive skew. E.C. WIKBERG, K.M. JACK, F.A. CAMPOS, A. SATO, M.L. BERGSTROM, T. HIWATASHI, S. KAWAMURA, L.M. FEDIGAN.
- 11:15 Chimpanzee hand-clasp grooming, a socially learned tradition, as a marker of social relationship. R.W. WRANGHAM, Z.P. MACHANDA, A. BERNARD, R. DONOVAN, I. GILBY, J. ROSEN, M. MULLER.
- 11:30 Red-hot males: Sexual strategies of high-ranking male rhesus macaques (*Macaca mulatta*). K.M. MILICH, C. DUBUC, S. WINTERS, W.L. ALLEN, K.A. ROSENFELD, S. GRAHAM, J.P. HIGHAM, D. MAESTRIPIERI.
- 11:45 The effects of paternity and male rank on male-immature relationships in the mountain gorilla (*Gorilla beringei beringei*). S. ROSENBAUM, J.B. SILK, J. HIRWA, L. VIGILANT, T.S. STOINSKI.

**Session 5: Thinking anthropologically about genetics***Invited Poster Symposium.* Chair: Bridget FB. Algee-Hewitt

Co-Organizer: Amy Goldberg

**Gateway Ballroom 2**

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

At its roots, Anthropology is a holistic science. Recently, however, the opposing forces of abundant data and increased specialization pose a challenge to scholars who want to contextualize their research within the larger discourse of population sciences. This is leading to less interaction and overlapping knowledge between researchers working on the same questions with different methods and data types. This symposium addresses this problem for the study of population history and dynamics. We argue that rather than partitioning our questions by field or data type, it is more productive to focus on ways to integrate multiple lines of evidence towards a coherent and satisfying story. The goal of this symposium is twofold. First, we aim to bring together researchers who exemplify a holistic approach, integrating multiple data types, for an audience that represents the many facets of biological anthropology. Second, we hope to start a mutually beneficial discussion between geneticists and researchers from other branches of anthropology working on similar questions. There will be two general groups of posters. First, those by geneticists looking for input from specialists in a range of fields, such as paleoanthropology, forensics, and primatology, and second, work that analyzes genetic data jointly with anatomical, archeological, ethnographic or linguistic data to study complex ideas that cannot be solved by one perspective, method, or dataset alone. To demonstrate the breadth of potential for this kind of integrative work, talks will cover a range of complex topics that support multicomponent approaches, such as the peopling of the Americas, linguistic and genetic co-evolution, and the interplay of demography with forensic identification.

- 8:40 High altitude adaptation and adaptive introgression in humans. R. NIELSEN.
- 9:00 The Impact of Hierarchical and Gene Flow Processes on Patterns of Regional Genetic Diversity. K. HUNLEY, G. CABANA, J. LONG.
- 9:20 Studying modern human migrations with integrated analyses of genetic and linguistic data. S. RAMACHANDRAN, N. CREANZA, M. RUHLEN, T.J. PEMBERTON, N.A. ROSENBERG, M.W. FELDMAN.
- 9:40 Studying the evolutionary history of Native North Americans. R.S. MALHI.

## Thursday Morning Sessions

- 11:00 Discussion: Lyle Konigsberg, University of Illinois, Champagne-Urbana.
- 1 A Multi- Component Analysis of Mexican Variation with Forensic Implications. C.E. HUGHES, B.F. ALGEE-HEWITT.
  - 2 A Synthesis of Archaeological and Mitochondrial Genome Data at the Eva Site. F.L. PACK, J. LINDO, R.S. MALHI, G.S. CABANA.
  - 3 The integration of genetic and phenotypic data to better understand human and non-human primate limb morphology. B.I. HULSEY, B.M. AUERBACH, L.M. HAVILL, C.C. ROSEMAN, G.S. CABANA.
  - 4 Evidence for the peopling of South America: archeological and genetic perspectives. A. GOLDBERG, A.M. MYCHAJLIW, D. SZTRAICHER, E.A. HADLY.
  - 5 *Population Structure in the United States: Using Forensic Data Bank Cases to Link Craniometric, Genetic and Social Information.* B.F. ALGEE-HEWITT.
  - 6 Parallel trajectories of genetic and linguistic admixture in Cape Verde. E.M. JEWETT, P. VERDU, T.J. PEMBERTON, N.A. ROSENBERG, M. BAPTISTA.
  - 7 A synthesis of genotype and phenotype reveals the multi-causal nature and complexity of human cranial evolution. C.C. ROSEMAN, G.F. KUHLMAN.
  - 8 Skin, hair, and iris pigmentation: quantifying phenotype and identifying genetic loci associated with variation in diverse populations. H.L. NORTON, M. EDWARDS, E. WERREN, E.J. PARRA.
  - 9 Use of high-throughput sequencing to investigate white-faced capuchin prey choice. E.K. MALLOTT, E. CLAUSING, R.S. MALHI.
  - 10 Phenotypic inference from ancient DNA. I. MATHIESON, W. HAAK, N. PATTERSON, S. MALLICK, B. LLAMAS, N. ROHLAND, E. HARNEY, S. NORDENFELDT, K. STEWARDSON, I. LAZARIDIS, J. PICKRELL, A. COOPER, G. BRANDT, N. NICKLISCH, H. MELLER, K.W. ALT, D. REICH.
  - 11 Examining Fingerprint Identification Through an Anthropological Lens. N.A. FOURNIER, A.H. ROSS.
  - 12 The Impact of Local Mate Exchange and Founder Effects on Global Patterns of Mitochondrial Genomic Variation. G.S. CABANA, K. HUNLEY.
  - 13 Beyond the Mantel test: phylogenetic mixed models and human cranial form as a multivariate response. D.C. KATZ, M.N. GROTE, T.D. WEAVER.
  - 14 Reconstructing the Effects of European Contact on North Slope Iñupiat Populations Through Genetic, Archaeological, and Ethnohistoric Research. J. RAFF, A. MIRO-HERRANS, A. JENSEN, M. RZHETSKAYA, L. ARMSTRONG, M. HAYES, D. BOLNICK.
  - 15 A case study on the multiple components of identity. A.C. BADER, R.S. MALHI.

**Session 6: Cahokia: Biological Evidence of Impacts and Interactions**

*Invited Poster Symposium.* Chair: Kristin M. Hedman

**Gateway Ballroom 3.**

Located across the river from modern-day St. Louis, Cahokia Mounds State Historic Site marks the location of the largest prehistoric mound center in North America and the epicenter of Mississippian culture from A.D. 1050-1350. At its peak, Greater Cahokia (including Cahokia, East St. Louis and St. Louis ceremonial precincts) covered 10-15 sq. km. Greater Cahokia was comprised of nearly 200 earthen mounds arranged around vast open plazas, with thousands of houses, temples and public buildings laid out in planned residential, political and ritual precincts. Population estimates for Greater Cahokia are as high as 20,000+ individuals and reflect the rapid consolidation of outlying communities and an influx of immigrants. Cahokia's power and influence flourished through the 12<sup>th</sup> and 13<sup>th</sup> centuries with archaeological evidence of an extensive interaction sphere extending from the Gulf Coast and Southeast, the Caddoan region to the south, through the Upper Mississippi River valley and the Great Lakes region. The bioarchaeology and political complexity of Cahokia is based largely on early analyses of the over 270+ individuals interred in Cahokia's Mound 72. These mortuary practices with their ritually elaborate burial events and human sacrifice have been considered as paradigmatic of a proto-urban, hierarchically organized polity. However, extensive excavations at the East St. Louis Mound center, and a comprehensive reanalysis of long neglected collections have given researchers a new perspective on Mississippian lifeways in the American Bottom. Recent osteological, isotopic and DNA studies focusing on inter- and intra-regional interaction provides new insight into the health, diet, geographic and biological origin of people occupying the midcontinent during the Mississippian period and revise our understanding of the rise and fall of the Cahokia polity.

7:30 – 8:00 a.m. Poster set-up, 11:45-12:00 a.m. Poster take-down.

10:00-10:30 Even numbered poster authors present

10:30-11:00 Odd numbered poster authors present

11:00 Discussion: George R. Milner, Penn State University.

- 1 The ISAS Cahokia Project: Rediscovering Ancient Cahokia . K.M. HEDMAN, E.A. HARGRAVE.
- 2 Assessing the Role of Migration in Cahokia's Population using Strontium Isotope Analysis. P.A. SLATER.
- 3 Stable carbon and nitrogen isotope analysis of early Mississippian diet at Cahokia mound 72. M.A. FORT, K.M. HEDMAN, S.H. AMBROSE.
- 4 Early Mississippian Health: Skeletal evidence from the East St. Louis Mound Center. K. MCDONALD, L. NASH, A. CARBAUGH.
- 5 Post-mortem processing and mass burials at Wilson Mound, Cahokia. S.E. BAIRES.

- 6 Ear removal: Skeletal evidence for trophy taking in the prehistoric Mississippian Midwest. A. CARBAUGH, K. ZEJDLIK.
- 7 Human Sacrifice in the Late Prehistoric American Bottom: Skeletal and Archaeological Evidence. L.M. NASH, E. HARGRAVE.
- 8 Politics as usual in west-central Illinois? Warfare and violence during the Mississippian Period at Cahokia and beyond. M.A. HATCH, S.D. SPENCER, E.A. HARGRAVE.
- 9 Mitochondrial aDNA characterization of Cahokia Mound 72. J.L. HARRISON, L. COSS, F.A. KAESTLE.
- 10 Complete Mitogenome Sequencing of Late Woodland domesticated dogs from Janey B. Goode. K.E. WITT, R.S. MALHI.

### Session 7: Inter-individual differences in collective action

*Invited Poster Symposium.* Chair: Luke Glowacki

Co-organizer: Chris von Rueden

#### Gateway Ballroom 4.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

10:00-10:30 Even numbered poster authors present

10:30-11:00 Odd numbered poster authors present

11:00 Discussion: Lee Cronk, Rutgers University

Models of collective action rarely account for differences across individuals beyond a limited set of strategies, ignoring variation in condition, motivation and personality. However, emerging evidence from the field of animal behavior indicates that these differences may have significant implications for the dynamics of collective action. For example, inter-individual differences within groups can generate leader-follower relationships that are integral to successful collective action. This research has only recently been extended to humans and non-human primates and has yet to be united into a single explanatory framework. This symposium aims to capture the breadth of inter-individual differences as they relate to collective action in humans and non-human primates. We bring together researchers studying diverse primate species and small-scale societies to present data on inter-individual differences in collective action. This symposium will 1) delineate similarities and differences in collective action across primates; 2) identify how inter-individual differences contribute to inter-specific differences in collective action; 3) explore how these data fit within the existing body of work on collective action; 4) and discuss how systematic cross-cultural and cross-specific comparisons might be made for future research.

- 1 Simultaneous tracking of wild baboons reveals individual and social drivers of troop organization. M.C. CROFOOT, A. STRANDBURG-PESHKIN, D. FARINE.
- 2 Social and ecological factors mediating female participation in collective action in black howler monkeys (*Alouatta pigra*). S. VAN BELLE.
- 3 Energy balance and stress responses correspond with individual participation by redtail monkeys in aggressive intergroup interactions. M. BROWN, M.E. THOMPSON.
- 4 Inter-individual variation in communal hunting in three wild chimpanzee communities. I.C. GILBY, Z.P. MACHANDA, D.C. MJUNGU, M.N. MULLER, A.E. PUSEY, R.W. WRANGHAM.
- 5 Individual contributions to pooled energy budgets: the Tsimane case. P.L. HOOPER, H.S. KAPLAN.
- 6 Interdependence, Risk-Pooling, and Environmental Change in Arctic Subsistence Economies: Ethnographic and Experimental Evidence. D. GERKEY.
- 7 Leadership and collective action in the HRAF probability sample. Z.H. GARFIELD, E.H. HAGEN.
- 8 Optimal foraging and ephemeral group formation of two societies on the boundary of theory. K. DEMPS, S. GLOVER KLEMETTI.
- 9 The Effects of Key Individuals on Collective Action. K. MCAULIFFE, R. WRANGHAM, L. GLOWACKI, A.F. RUSSELL.
- 10 Leadership in an egalitarian human society. C.R. VON RUEDEN, M. GURVEN, H. KAPLAN, J. STIEGLITZ.
- 11 Differences between leaders and non-leaders in small-scale warfare and implications for collective action. L. GLOWACKI.

## Thursday, All day sessions.

### Session 8: Paleoanthropology: Primate evolution

*Contributed Poster Presentations.* Chair: Mary T. Silcox.

#### Archview Ballroom.

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30- Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 First postcranial material assigned to *Agerinia roselli* (Primates, Adapiformes) from Les Saleres (Early Eocene, Catalonia, Spain). J. FEMENIAS-GUAL, J. MARIGÓ, R. MINWER-BARAKAT, S. MOYÀ-SOLÀ.
- 2 Implications of occlusal contacts in Caenopithecids (Adapiformes) and extant Lemuriforms. H.L. KRISTJANSON, J.M. PERRY, E.M. ST CLAIR.
- 3 From inner ear to lifestyle : paleobiology of a fossil primate from Eocene. M. BERNARDI, S. COUETTE.



## Thursday All Day Sessions

- 4 Dental topography and dietary ecology of the first North American euprimates. P.E. MORSE, J.I. BLOCH, G.S. YAPUNCICH, D.M. BOYER, S.G. STRAIT.
- 5 Did climate change trigger megafaunal extinctions in Madagascar? L.R. GODFREY, B.E. CROWLEY, K.E. SAMONDS, M.R. SUTHERLAND.
- 6 First virtual endocasts of North American adapiform primates. A.R. HARRINGTON, M.T. SILCOX, G.S. YAPUNCICH, D.M. BOYER, J.I. BLOCH.
- 7 Microsycopids from the Early Eocene of the Southern Bighorn Basin, Wyoming: evolutionary insights from the largest stratigraphically controlled sample of stem primates. M.T. SILCOX, K.D. ROSE, A.E. CHEW.
- 8 Partial skeleton of early Eocene *Tinimomys graybulliensis* (Primates, Micromomyidae) from the Clarks Fork Basin, Wyoming. S.G. CHESTER, E.J. SARGIS, J.I. BLOCH, D.M. BOYER.
- 9 Unique morphology found in the first tarsal bones of *Antillothrix bernensis*, a medium-sized Caribbean platyrrhine subfossil. J.T. GLADMAN, A.L. ROSENBERGER.
- 10 Investigating the variation at pterion across platyrrhines, with special attention to *Alouatta*. L.B. HALENAR.
- 11 Phylogeny, ecology and craniodental evolution in the atelid primates. A. BJARNASON, C. SOLIGO, S. ELTON.
- 12 The first major primate extinction: Testing competitive exclusion in the fossil record of North American stem primates using dental topography. K.A. PRUFROCK, D.M. BOYER, M.T. SILCOX.
- 13 The biogeographic origins of major primate clades. S. LOPEZ-TORRES, M.T. SILCOX.
- 14 Endocranial globularity and brain size in primates. K.L. ALLEN.
- 15 Integration of nervous system tissues into primate phylogenetics. B.M. SHEARER.
- 16 Cell number and volume of primary visual cortex in primates. D.J. MILLER, R. PATHAK, P. BALARAM, J.H. KAAS.
- 17 Geospatial Paleoanthropology: predicting and locating new fossil localities with approaches from the spatial sciences. R.L. ANEMONE, C.W. EMERSON, B. NACHMAN, A. BRYANT, G.C. CONROY.
- 18 Intraspecific Semicircular Canal Variance—A Missing Element in Adaptive Scenarios? L.A. GONZALES, M.D. MALINZAK, R.F. KAY.
- 19 Cranial sexual dimorphism in *Papio hamadryas kindae*: same or kinda different? M. SINGLETON, B.C. SEITELMAN, S.R. FROST.
- 20 A preliminary paleoecological analysis of newly discovered fossiliferous localities at the middle Miocene site of La Venta, Colombia. M. TALLMAN, S.B. COOKE, B.M. SHEARER, A. LINK.
- 21 Review of Olduvai cercopithecoids reveals a newly recognized taxon and biochronological connection to South Africa. C.C. GILBERT, S.R. FROST, E. DELSON.
- 22 Morphological affinities of recently discovered Cercopithecids from the Pliocene Upper Laetolil Beds at Laetoli, in northern Tanzania. E. ABELLA, C.M. MUSIBA, T. LANCASTER.
- 23 Patterns of taxonomic diversity and relative geographic occupancy of Mio-Pliocene crown Catarrhini. E.M. LOCKE.
- 24 *Cercopithecoides williamsi* shows the earliest fossil evidence for pollical reduction in a fossil colobine. S.R. FROST, C.C. GILBERT, K.D. PUGH, E.H. GUTHRIE, E. DELSON.
- 25 Phylogenetic relationships of living and fossil African papionins: combined evidence from morphology and molecules. K.D. PUGH, C.C. GILBERT.
- 26 Cranial shape and intrageneric diversity in the genus *Cercopithecoides*. M. ANDERSON, S.R. FROST, C.C. GILBERT, E. DELSON.
- 27 Primate community evolution in the southern African Plio-Pleistocene: Dietary overlap and niche differentiation of fossil cercopithecoids. I.E. SMAIL.
- 28 Establishing the orientation and biobehavioural implications of the semicircular canals of *Cercopithecoides haasgati*. A. OLAH, M.R. MCCURRY, J.W. ADAMS.
- 29 Functional/adaptive implications of the metacarpophalangeal joint in primates and their relatives. K.T. VO, D.M. BOYER.
- 30 Similarities in the primate vertebral formulae and implications for phylogeny and locomotor behavior. A.B. LEE, L.W. KONIGSBERG, S.A. WILLIAMS.
- 31 A method for assigning sex based on the size and shape of the upper and mid-face. K.L. BALOLIA, M.W. GRABOWSKI, B. WOOD.
- 32 A new anthropoid first metatarsal from the early Miocene site of Songhor, Kenya. C. TRAN, I.O. NENGO, B.A. PATEL.
- 33 Incisor variation at middle Miocene Maboko indicates the possible presence of at least two small-bodied ape species. E.R. DAVIS, B.R. BENEFIT, M.L. MCCROSSIN.
- 34 The phylogenetic position of *Proconsul* and the difficulty of dealing with stem taxa in the fossil record. A.D. BALES.
- 35 First evidence of Nyanzapithecinae at Moroto II, Uganda. R.J. JANSMA, L.M. MACLATCHY.
- 36 A revised taxonomy of *Proconsul* modelled on dental variation in extant hominoids. H. WEAVER, V. PILBROW.
- 37 A preliminary study of pelvic and femoral shape covariation in anthropoids. A.S. HAMMOND, N.P. OLAKKENGIL, S. ALMÉCJA.
- 38 The Body Mass of *Victoriapithecus macinnesi* Revisited Using Foot Remains. I.D. ARNEY, B.R. BENEFIT, M.L.

MCCROSSIN.

- 39 The plesiomorphic condition of the great ape femur: biomechanical evidence from the IPS41724 femur (middle Miocene, NE Iberian Peninsula). M. PINA, S. ALMÉCIJA, C.B. RUFF, D.M. ALBA, S. MOYÀ-SOLÀ.
- 40 The systematic status of *Bunopithecus sericus*, a Pleistocene gibbon from Chongqing Province, southern China. A. ORTIZ, V. PILBROW, C.I. VILLAMIL, J.G. KORSGAARD, S.E. BAILEY, T. HARRISON.
- 41 Craniomandibular integration in anthropoid primates with implications for mandibular symphyseal fusion. R.P. KNIGGE.

### Session 9: Bioarchaeology

*Contributed Poster Presentations.* Chair: Amelia R. Hubbard. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Multivariate cranial affinity of paleoamerican crania from Lagoa Santa, Brazil in comparative global context: A 3D geometric morphometric analysis. N. VON CRAMON-TAUBADEL, A. STRAUSS, M. HUBBE.
- 2 Craniometric variation in Ancient Egypt and influences from the East. A.R. KLALES, J.P. ELIAS, R.D. HOPPA.
- 3 Migrating Huns and modified heads: Eigenshape analysis comparing crania from Hungary and Georgia. P.R. MAYALL, V. PILBROW.
- 4 Cranial deformation in an Ohio River Valley Adena Population. A.M. CASADO, L.T. CRITCHER, M.A. CLARK.
- 5 New data on Late Upper Paleolithic upper limb cross-sectional geometry from Arene Candide: implications for Tardiglacial hunting practices. V.S. SPARACELLO, C.N. SHAW, D. MARCHI.
- 6 Geometric Morphometric Analyses of the Greater Sciatic Notch at Neale's Landing (46WD39) and Lyon's Bluff (22OK520): A Preliminary Study. S.M. ZALESKI, K.J. WEINSTEIN, N.P. HERRMANN.
- 7 3D Scanning and Morphometric Analysis of the Tibia: Insights into Nubian Activity Patterns. S.L. HACKNER.
- 8 Three-dimensional documentation of human skeletal remains using 123DCatch software: a reliability of distance measurements. P. GALETA, V. SLÁDEK, J. MACHÁČEK.
- 9 Biomechanical Analyses of Femoral Robusticity at Paquime, Chihuahua, Mexico. K.D. WALLER.
- 10 Basketmakers revealed: Physical, CT, and 3D analyses of mummified human remains from the southwest. K.D. SHERWOOD, D.W. OWSLEY, K.S. BRUWELHEIDE, S.L. ROUSE, D.E. HURLBERT.
- 11 A test of the agreement between mitochondrial DNA and nuclear microsatellite based reconstructions of biological distance among regional populations. A.R. HUBBARD, R.L. RAAUM.
- 12 Dental Phenetic Variation in a Mass Human Sacrifice on the North Coast of Peru: Kinship, Mortuary Symbolism, and Identity among the Victims of Matrix 101 (Middle Sicán Culture, A.D. 1050/1100). J.E. YOUNG, H.D. KLAUS, J. PINILLA, A. ALVA, C. ELERA.
- 13 A comparison of genetic and morphometric sex determination techniques in a commingled collection from Byzantine St. Stephen's monastery, Jerusalem. R.C. MAYUS, S. GUISE SHERIDAN, F.L. PACK, J. ULLINGER, G.S. CABANA.
- 14 Mixed signals: a comparison of sex determination ratios within and between bones in a fragmentary, commingled skeletal assemblage. C. REICH, S. SMITH, R. MAYUS, S. GUISE SHERIDAN.
- 15 A Multidisciplinary Approach to Analyzing Sex and Gender in the Ancient World using aDNA and Stable Isotope Analysis: A Pilot Study from the Dakhleh Oasis, Egypt. K.E. EAST, T.L. DUPRAS, K. CHUMBIMUNI-TORRES, L. WILLIAMS, D.M. KOLPASHCHIKOV.
- 16 A Transparent Method for Sex Estimation Using Refined DSP Measurements of the Innominate. S.E. BAUMGARTEN, S.D. OUSLEY, S.J. DECKER, N.R. SHIRLEY.
- 17 Three Age Indicators of the Adult Human Pelvis and the Influence of Occupation on Morphology. M. MIRANKER.
- 18 Senescence changes in palatal suture fusion across populations: applying a revised scoring method for age estimation using transition analysis. K. GODDE, S.M. HENS.
- 19 Skeletal Age Estimates: A Comparison of Four Methods. A. TREMBLAY.
- 20 New estimates for stature in the Roonka Flat skeletal sample using the Revised Fully Technique. A.C. DURBAND, E.C. HILL, K. WALSH.
- 21 Stature reconstruction from long bones in population of the South-central Inner Mongolia from Bronze age to Early Iron age. M. LIU.
- 22 An analysis of estimation of maximum length in incomplete long bones. E.E. GOMBERG, M.E. DANFORTH.
- 23 Social reorganization and biological change: an examination of stature variation among Iron Age Samnites from Abruzzo, Italy. G. VERCELLOTTI, V.S. SPARACELLO, A. COPPA.
- 24 Mortuary archaeology of 87 Seventeenth Century burials from the Swahili stone town Mtwapa. L.G. PROCTOR, C. KUSIMBA, J. MONGE, M. MCHULLA, S. WILLIAMS.
- 25 Exploratory data analysis in bioarchaeology using latent class analysis. N.V. PASSALACQUA.
- 26 Stories in Bones Still Told: Digitization of The Clover Site, Fort Ancient human remains. K.D. HENSON, P. CONSTANTINO, N. FREIDIN.
- 27 Burial Patterns of the Pre-Classic Maya at Colha, Belize. B. SNOWDEN, A. DURBAND, B. HOUK.



## Thursday All Day Sessions

- 28 Hidden Heterogeneity in a Modern Skeletal Sample. J.D. MINSKY-ROWLAND.
- 29 Preliminary osteological analyses of the early Medieval Prussian population at Bezlawki, Poland. A. GRUENTHAL-RANKIN, M. RAMSIER, A. KOPERKIEWICZ, M. POLCYN.
- 30 Cultural Interaction and Biological Distance in Postclassic Period Mexico. C.S. RAGSDALE, H.J. EDGAR.
- 31 Mapping Migration: Tracing Ancient Human Mobility via Local Bioavailable Strontium Isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) Signatures in the Iberian Peninsula. A.J. WATERMAN, J.T. THOMAS, D.W. PEATE.
- 32 Using Dental Morphology to Assess Ancestry at an historic Indiana site. H. MILLER.
- 33 Identifying Recent Migrants to a Revolutionary War-era Charleston Slave Cemetery using oxygen isotopes. C.A. JUAREZ, J. LAMONTAGNE, S. ABEL, W. THOMAS.
- 34 Isotopic evidence for the origins of homicide victims from Qasr Hallabat. K.A. PARKER, M.A. PERRY, D.S. COLEMAN, D.L. DETTMAN.
- 35 Preliminary results of the bioarchaeological investigation of an Iron Age tomb at Wadi Fidan 61, Jordan. A.R. HOFF, T.E. LEVY.
- 36 Temporal Survival Analysis of Medieval St. Mary Spital Cemetery, London (c. 1120-1400 CE). B.S. WALTER, S. DEWITTE.
- 37 Intrasite bioarchaeology of the Moundville Cemeteries: Preliminary investigations. J.L. FUNKHOUSER.
- 38 Prevalence of drifting osteons across mammalian species. K. MCCULLOUGH FRENCH, S.R. MAVROUDAS, V.M. DOMINGUEZ.
- 39 Musculoskeletal stress markers of males and subsistence strategy changes between Jomon people and Yayoi people. S. YONEMOTO, N. SEGUCHI.
- 40 A dental approach to salvage excavated and commingled burials. J. BECK.
- 41 How many in the tomb of Tiy? Calculating the number of individuals interred in a Nubian 18<sup>th</sup> Dynasty pyramid tomb from Tombos, Sudan. S.J. CALDWELL, K.M. WHITMORE, M.R. BUZON.
- 42 What counts in the end? - Determining the MNI for the commingled and fragmented bone assemblage from the Middle/Late Bronze Age Tomb VII, Qatna (Tell Mishrife, Syria). S. DEGENHARDT, S. FLOHR, H. DOHMANN-PFÄLZNER, P. PFÄLZNER, C. WITZEL.
- 43 Homogeneity of Tetracycline Labeling Across Classes in Early Christian Burials from Kulubnarti, Nubia. J.A. MARGOLIS, D.P. VAN GERVEN, G.J. ARMELAGOS.

**Session 10: Skeletal Biology: Paleopathology and Violence**

*Contributed Poster Presentations.* Chair: Carina Marques. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Analysis of Native American Scalping From The Chavez Population. A.M. BEYENS.
- 2 Interpersonal Violence, a View from the Huacas de Moche, North Coastal Peru. C.M. GAGNON.
- 3 Three dimensional cut mark analysis in order to discern ancient cutmark tools. J.B. SCHNELLENBERGER, C. SCHMIDT.
- 4 Scars of Alabama: Bioarchaeology of Violence among Riverine Islanders. B.D. PADGETT, K.P. JACOBI.
- 5 Changing Skeletal Stress Following Social and Political Disruption at Karystos, Greece. J.T. WHARRY, B.K. MCILVAINE.
- 6 Violence and conflict in prehistoric northwest Mexico. A.M. OFFENBECKER, J.H. KELLEY, M. KATZENBERG.
- 7 An Unusual Interment of Dismembered Legs and Hands: A Roman Umbria burial puzzle. J.A. RHODES, J.D. MUCCIGROSSO.
- 8 The growing divide: emergent social inequality in San Pedro de Atacama during the Middle Horizon. S.M. BUCK, M. HUBBE, C. TORRES-ROUFF, W.J. PESTLE.
- 9 Differences in Diet Between and Within Medieval Fishergate House, York, and Wharram Percy, Yorkshire: As Told by Dental Calculus and Scanning Electron Microscopy. S. CLARKE, T. JAKOB.
- 10 Cranial clusters: Mortuary patterns in Eneolithic Verteba Cave, Western Ukraine. S.E. HEINS, J.K. KARSTEN, G.D. MADDEN.
- 11 Complex evidence of stress in medieval and post-medieval central Europe. L.L. WILLIAMS, D. GUATELLI-STEINBERG, C.S. LARSEN, P.W. SCIULLI.
- 12 Anemia, stress, and mortality in an historic Portuguese skeletal sample. K.M. MACAK, K. GODDE, S.M. HENS.
- 13 Potential False Negatives: A Preliminary Analysis of Non-Diagnoses for Pulmonary Tuberculosis Based on Non-Observation of Inflammatory Rib Lesions. J. CHAN.
- 14 Paleoepidemiological approaches to treponemal disease. K.A. SANDHU, M.K. ZUCKERMAN, B.L. HIGGS, K.N. HARPER, K.R. KAMNIKAR, W.M. SULLIVAN.
- 15 Tuberculosis in the American Museum of Natural History Medical Skeletal Collection: Comparing an Osteological Dataset to Historical Records. A.M. LANS.
- 16 Pathological traits in Neolithic skeletal remains – Earliest evidence for leukemia? H. SCHERF, M. FRANCKEN, J. WAHL, K. HARVATI.
- 17 Cortical Bone Loss and Osteoporotic Fractures in the Coimbra Identified Skeletal Collection. F. CURATE, E. CUNHA, V. MATOS, D. NAVEGA, J.P. LIMA.
- 18 Vertebral lesions from a Geriatric sample exhumed from the St. Nicholas Cemetery, Limassol, Cyprus. C.E. MAYER, R. PAINE,

- X. KYRIAKOU.
- 19 Degenerative Joint Disease in the Hands and Feet Relative to Sex and Body Mass: A Study of Skeletons from St. Nicholas Cemetery in Limassol, Cyprus. L.C. HIGHSMITH, R.R. PAINE, X. KYRIAKOU.
  - 20 Femoro-acetabular impingement in a skeletal assemblage from medieval Nubia. A.B. LAWRENCE, P.A. SANDBERG.
  - 21 Temporal change in the prevalence and pattern of periostosis in Woodland Period northern Illinois. M.O. SMITH, L. MALEKFAR.
  - 22 A bioarchaeological exploration of scorbutic cranial lesions and a proposed etiology. T.M. CARGILL.
  - 23 Physical Anthropology in the Renaissance as revealed by the medical writings of the Portuguese physician Amatus Lusitanus (1511-1568). C. MARQUES, V.M. MATOS.
  - 24 Artificial Deformation vs. Normal Variation: Re-examination of the Deformed Craniums in Ancient Korean Populations. E. WOO, H. JUNG, Y. JEONG, S. PAK.
  - 25 A multi-joint case of avascular necrosis in a prehistoric Native American female. R.A. JOHNSTON, S.L. CHILD, L.W. COWGILL.
  - 26 Lurking in the genes: A case study of reactive arthropathy in comparison to other HLA-B27 related conditions and DISH. W.D. CAWLEY, R.R. PAINE, X. KYRIAKOU.
  - 27 Assessment of lesions of the rotator cuff (Rotator Cuff diseases (RCD)). L. SCHWARZ, N. BEREZINA, J. GRESKY.
  - 28 Abnormal healing of a femoral spiral fracture and its functionality in a Cypriot Geriatrician. S. HAILESELASSIE, R.R. PAINE, X. KYRIAKOU.
  - 29 The forgotten pathology: Middle ear disease at Mount Nebo, Jordan. A.P. CULLEN DOYLE, M.A. JUDD.
  - 30 A possible case of cleft palate in early Florida as identified through 3D imaging: The intersection of modern technology and bioarchaeological analysis to record and analyze behavior and medical conditions of an Archaic--Glades II population. J.W. POWELL, L. NOCHE-DOWDY, A.L. HUMPHRIES, A. RIVARA, E.H. KIMMERLE.
  - 31 A Middle Woodland Co-mingled Burial with Evidence of Rickets. H.E. MARSH.

### Session 11: Dental Anthropology: Human and Non-human Primates

*Contributed Poster Presentations.* Chair: Andrew S. Deane. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 South American Dental Patterning: Assessment of the Sinodont and Sundadont dental complexes. M.M. HUFFMAN.
- 2 Odontometric sex estimation using cervical canine measurements. A comparison of an early Neolithic and an early medieval assemblage. S. FLOHR, H. KIERDORF, U. KIERDORF.
- 3 Population systematics of *Pongo* from discrete dental traits. V. PILBROW.
- 4 The patterning cascade model and Carabelli's cusp expression in metameremes of the mixed human dentition: exploring a morphogenetic model. C.M. ASTORINO, K.S. PAUL, S.E. BAILEY.
- 5 An intraspecific analysis of the inhibitory cascade (IC) model in gorillas, chimpanzees, and modern humans. E. DALY, K.K. CATLETT, K.S. PAUL, H.P. NESSE.
- 6 Measures of dental relief: testing error, testing efficacy. M.J. VILLAFUERTE, S.B. COOKE.
- 7 Degree of sexual dimorphism in odontometrics and arcade dimensions in modern American populations. D. ADAMS.
- 8 Changes in tooth form between Roman, Anglo-Saxon and modern periods in Britain: a study of differences in size, morphology and wear. S.R. ZAKRZEWSKI, C. FERNEE, A. DICKINSON, C. WOODS.
- 9 Predicting M1 Crown Area from dm2 in Modern and Fossil *Homo*. E.S. GLAZE, S. BAILEY.
- 10 Anthropoid incisor crown bending strength and dietary mechanical loading: *What's curvature got to do with it?* A.S. DEANE.
- 11 A biomechanical perspective on variation in molar emergence ages in Primates. H. GLOWACKA, G.T. SCHWARTZ.
- 12 The Mandibles of Castrated Male Rhesus Monkeys (*Macaca mulatta*). Q. WANG, M.J. KESSLER, T.B. KENSLER, P.C. DECHOW.
- 13 Malocclusion and cranial modification: assessing maxillary occlusal variation in artificially modified crania. S.I. PACHECO-FORÉS.
- 14 Variation in primate enamel formation front angles. D. GUATELLI-STEINBERG, R. FERRELL, J. PAMPUSH.
- 15 Spatial variation of dentine hardness in the molars of three primate taxa. E. GEISSLER, A.C. DUQUE, J.D. PAMPUSH, D.J. DAEGLING, W.S. MCGRAW.
- 16 Lateral enamel formation of anterior teeth and life history in New World monkeys. A.N. CLARK, D. GUATELLI-STEINBERG, M. HUBBE, R. FERRELL.
- 17 A comparison of *Pan paniscus* and *Pan troglodytes* perikymata distribution in upper incisors and lower canines by crown length and height. M. O'HARA, D. GUATELLI-STEINBERG.
- 18 Patterns of premolar molarization in platyrrhine and catarrhine primates. J.E. SCOTT, R.M. CAMPBELL.
- 19 Variation of Enamel Decussation in the Permanent Molars of *Papio ursinus*. D. YANG, F.E. GRINE.
- 20 Analysis of incisor microwear in five genera of platyrrhine primates. L.K. DELEZENE, M.F. TEAFORD, S.V. LIVINGOOD, P.S. UNGAR.

## Thursday All Day Sessions

- 21 Rates of dental microwear in laboratory primates track changes in food items consumed. M.F. TEAFORD, A.B. TAYLOR, J. IRIARTE-DIAZ, C.F. ROSS, C.J. VINYARD.
- 22 Dental health in a wild population of ring-tailed lemurs (*Lemur catta*) at the Beza Mahafaly Special Reserve and Tsimanampesotse National Park, Madagascar. M.L. SAUTHER, F.P. CUOZZO, J.P. MILLETTE.
- 23 Folivores, frugivores, and *Theropithecus*: Diet and dental topography in cercopithecoids. J.M. WINCHESTER, E.M. ST. CLAIR, D.M. BOYER.
- 24 From the mouths of babes: is Moorrees method appropriate for age estimation of Prehistoric Native American children? S.H. BLATT.
- 25 Dental maturity score in chimpanzees. K.L. KUYKENDALL.
- 26 Linear enamel hypoplasia prevalence in wild Virunga mountain gorillas from Rwanda. K. MCGRATH, D. GUATELLI-STEINBERG, K. ARBENZ-SMITH, D.J. REID, M.R. CRANFIELD, T.S. STOINSKI, A. MUDAKIKWA, T.G. BROMAGE, S.C. MCFARLIN.
- 27 Is stress beneficial to longevity? Linear Enamel Hypoplasia (LEH) and age at death in the Medieval St. Gregory's Cemetery, Canterbury, UK. R.M. PERASH.
- 28 Front lines and cementum lines. An attempt to identification of soldiers from the World War I using cementochronology. B. BERTRAND, T. COLARD, J. RAMOS MAGALHAES, H. PHELIPPEAU, F. GERMAIN, L. GÉANT-CAPARROS, A. PÉLISSIER, M. LANDOLT.
- 29 Taurodontism in Review: Methods of determination and anthropological utility. S.S. LEGGE, A.M. HARDIN.
- 30 Assessing sex and ancestry using cemento-enamel junction diameters of modern Americans. L.S. GENTNER, S.D. OUSLEY.
- 31 Dental trauma and primate sociality. C.A. KIRCHHOFF.
- 32 Analysis of dental pathologies from the Late Woodland osteological sample from Schroeder Mounds. M.K. COAD, M. BAUERLE, M. OSTENDORF SMITH.
- 33 Commingled Remains, Dental Health, and Subsistence at the Smith Creek Site in Mississippi. R.M. SEIDEMANN, C.L. HALLING.
- 34 Legions of lesions: An examination of the severity and prevalence of dental caries in medieval Bögöz. J.E. ROTHWELL, D.W. HANSEN II, J.D. BETHARD, A. GONCIAR, Z. NYÁRÁDI.
- 35 Assessing Oral Health Differences in Socially Distinct Classic Period Maya Populations. E.C. BLANKENSHIP-SEFCZEK, P. MITCHELL, S.R. BLACK, T.M. SEFCZEK.
- 36 Oral Health Inequality and the Erie County Poorhouse (1851-1913) in Light of the American Dental Revolution. K.C. KNOWLES, J.E. SIRIANNI.
- 37 Oral Health of the Middle and Late Woodland in the Mississippi River Valley of Illinois. M.C. BAUERLE, M.O. SMITH.

**Session 12: Primatology: Life History**

*Contributed Poster Presentations.* Chair: Valerie AM Schoof. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Distinguishing among polygynandrous species based on the relative intensity of pre- vs. post-copulatory, male-male competition: a multivariate approach. A. VAN HORN, K.D. ALMSKAAR, L. ROCKWELL.
- 2 Long-term site fidelity and reproductive success in female sifaka (*Propithecus verreauxi*) at Beza Mahafaly, Madagascar. D.K. BROCKMAN, M. SCHWARTZ.
- 3 Offspring of Primi-parous Mothers Do Not Experience Higher Mortality or Poorer Growth: Revisiting the Conventional Wisdom with Archival Records of Rhesus Macaques (*Macaca mulatta*). C.L. NUNEZ, M.N. GROTE, M. WECHSLER, C. ALLEN-BLEVINS, K.J. HINDE.
- 4 Differential maternal investment in rhesus monkey mothers with hair loss in the neonatal period. A.M. DETTMER, K. ROSENBERG, M.T. MENARD, S.J. SUOMI, J.S. MEYER, M.A. NOVAK.
- 5 Weaning and hominoid life history: Serial isotopic sampling of *Pan troglodytes* tracks dietary change across development. M. MALONE, L. MACLATCHY, J. KINGSTON, R. KITYO.
- 6 Body growth in wild mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda. D. ABAVANDIMWE, J. GALBANY, T. BREUER, F. NDAGIJIMANA, T.S. STOINSKI, S.C. MCFARLIN.
- 7 Determinants of primate sex ratios: an analysis of demography in Verreaux's sifaka (*Propithecus verreauxi*). K.G. LEIMBERGER, R.J. LEWIS.
- 8 Preliminary findings on demography and dispersal of Kinda baboons (*Papio kindae*). A.P. SWEENEY, A.H. WEYHER.
- 9 Female rank and infanticide in Nepal Gray langurs. C. BORRIES, A. KOENIG.
- 10 Paternity analysis and friendship in a group of Kinda baboons (*Papio kindae*). A.H. WEYHER, A.S. BURRELL.
- 11 Does relative pituitary gland size predict mammal life history? J.M. KAMILAR, S.R. TECOT.
- 12 Ontogeny of nasal turbinates in *Lemur catta*. M.C. MARTELL, E.E. POWELL, T.D. SMITH, V.B. DELEON.
- 13 The single life: Physical injuries may reflect the costs of being a solitary owl monkey. M.K. CORLEY, M. ROTUNDO, V. DÁVALOS, M. HUCK, A. DI FIORE, E. FERNANDEZ-DUQUE.
- 14 Vervets in an anthropogenic landscape: Reduced breeding seasonality and mixed diet. V.A. SCHOOF, D. TWINOMUGISHA,

## Thursday All Day Sessions

J.A. TEICHROEB, J.M. ROTHMAN, C.A. CHAPMAN.

15 Dikika cercopithecids and paleoenvironment. C.M. SEYOUM, Z. ALEMSEGED.

16 Do diet and evolutionary history predict variation in life history variables better than environmental harshness for lemur traits? L.L. TAYLOR, J.P. HERRERA.

**Session 13: Anthropological Genetics**

*Contributed Poster Presentations.* Chair: Jennifer G.L. Kennedy. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Worldwide genetic variation and kinship systems: An anthropological perspective on human origins research. G.V. DZIEBEL.
- 2 Uncovering ancestry: Public attitudes toward genetic ancestry testing. H. GLASS, E. KELLY, A.L. NON, N.A. GARRISON.
- 3 Ancient DNA analysis of human remains from the Siberian Arctic. E.J. LEE, D. MERRIWETHER, A.K. KASPAROV, V.I. KHARTANOVICH, P.A. NIKOLSKIY, F.K. SHIDLOVSKIY, V.B. TIMOSHIN, E. PAVLOVA, V.V. PITULKO.
- 4 Metagenomic analysis of Alaskan ice mummies. G. FERRARI, M.R. ZIMMERMAN, F.J. RÜHLI, A.S. BOUWMAN.
- 5 Evidence of Paleohistorical Atlantic and Pacific transoceanic genetic and cultural contacts. A. ARNAIZ-VILLENA, C. ARECES, M. ENRIQUEZ-DE-SALAMANCA, J. MARCO, E. MUÑIZ, M. FERNÁNDEZ-HONRAD, D. RAY.
- 6 Insights into Native North American Admixture Patterns from Whole Genome Sequencing. A.T. MIRO HERRANS, J.A. RAFF, R.S. MALHI, M.H. CRAWFORD, M. HAYES, D.A. BOLNICK.
- 7 Dynamics of cultural transmission in Native Americans of the High Great Plains. S. LYCETT.
- 8 Comparison of aDNA yields from calculus and tooth roots in pre-Columbian skeletal remains. M.A. NIEVES-COLON, A. OZGA, T.P. HONAP, W.J. PESTLE, C. WARINNER, A.C. STONE.
- 9 Investigating the Genetic Effects of Spanish Colonialism: A Comparison of Ancient and Modern Mitochondrial DNA from Xaltocan, Mexico. J. MATA-MÍGUEZ, K.M. SAMMS, R.H. VANDEVERE, E. RODRÍGUEZ-ALEGRÍA, L. OVERHOLTZER, D.A. BOLNICK.
- 10 Maternal and paternal population history of Indigenous individuals in British Columbia. A.C. OWINGS, C.E. HUGHES, M.P. ROGERS, J.S. CYBULSKI, R.S. MALHI.
- 11 Adaptation to milk consumption and evolution of lactase persistence in goat herders from Central-Northern Chile. N. MONTALVA.
- 12 Lactase non persistence among four Chilean populations. C.I. FERNANDEZ, N. MONTALVA, M. ARIAS, M. HEVIA, M. MORAGA, S.V. FLORES.
- 13 Ancient DNA and isotopic analyses of human skeletal remains from Chelechol ra Orrak, Republic of Palau. J.H. STONE, J. TACKNEY, D.H. O'ROURKE, J. KRIGBAUM, S.M. FITZPATRICK, G.C. NELSON.
- 14 Within and beyond Africa: Genetic ancestry of Jamaican Maroons. F.M. SAAVEDRA, J.P. BENN TORRES.
- 15 Ancient Mitochondrial DNA Analysis of the Roman/Parthian Period Cemetery at the Site of Tall Šēḥ Ḥamad, Syria. J.G. KENNEDY, D. MERRIWETHER.
- 16 No longer the 1%: Optimizing ancient DNA yield from Saharan African samples. K.A. SIRAK, D.M. FERNANDES, S. CONNELL, R. PINHASI.
- 17 Mitochondrial haplogroups detected in medieval population from 10<sup>th</sup> -11<sup>th</sup> century on the territory of the West Slovakia. V. CSAKYOVA, M. NAGY, A. CSOSZ, B. MENDE, M. BAUER, P. MAKOVICKY, M. MARTINIAKOVA, M. BAUEROVA.
- 18 Genetic identity and mitochondrial analysis of the Taita in eastern Kenya. P.S. WHYMS, K. BABROWSKI, K. BATAI, C. KUSIMBA, S. WILLIAMS.
- 19 Modern DNA analysis of the Mijikenda. E.D. LEENHEER, K. BATAI, K. BABROWSKI, P. WHYMS, C. KUSIMBA, S.R. WILLIAMS.
- 20 Rejection of one-time and fixed-rate admixture models in African Americans. J.M. GROSS, J.C. LONG.
- 21 Allostatic load varies by genotype, age, sex, and social factors in American Samoans. G.A. DONLEY, D.E. CREWS.
- 22 Genetic variants and alcohol intake patterns in university population in Santiago of Chile. C.P. SILVA GALLARDO, S.V. FLORES CARRASCO.
- 23 Admixture Mapping of Coronary Artery Calcification in the NHLBI Family Heart Study (FamHS). F. GOMEZ, L. WANG, H. ABEL, Q. ZHANG, M. PROVINCE, I. BORECKI.

**Session 14: Bioarchaeology: Growth, Nutrition and Health**

*Contributed Poster Presentations.* Chair: Kara C Hoover. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Evolving to Eat: Food composition and human mandible morphology. R.M. BYRD.
- 2 The Crypt People from the Cathedral Basilica of Saints Stanislaus and Vladislaus, Vilnius, Lithuania: Reconstruction of Life Histories using Stable Isotope Analysis. K.L. SCHOTTEN, T.L. DUPRAS, R. JANKAUSKAS, L.J. WILLIAMS, S. HOLDER, J.J. SCHULTZ.

## Thursday All Day Sessions

- 3 Change Between Femoral to Humeral Stable Isotopic Nitrogen and Carbon Values During Growth from a Sample of Subadults at Alytus, Lithuania. K.E. PAGE, T.L. DUPRAS, R. JANKAUSKAS, L.J. WILLIAMS, C.D. ELEAZER, J.J. SCHULTZ, S.M. WHEELER.
- 4 Feeding the city: Isotopic reflections of diet at 1<sup>st</sup> century Petra, Jordan. L.M. APPLETON, M. PERRY.
- 5 Dietary Change Following Social Transition at Karystos, Greece. S.P. FIELD, B.K. MCILVAINE.
- 6 An assessment of degenerative joint disease of the hip and shoulder in a Cypriot community from Limassol, Cyprus. L. RODRIGUEZ, R.R. PAINE, X. KYRIAKOU.
- 7 Variation in regional diet and mandibular morphology in prehistoric Japanese hunter-gatherer-fishers. K.C. HOOVER, F.L. WILLIAMS.
- 8 Biocultural consequences of Spanish contact in the Lambayeque Valley region of northern Peru: Stable isotope and dental microwear analysis as indicators of diet, subsistence, and mobility. K.T. BROOKS, C.J. GARLAND, B.L. TURNER-LIVERMORE, H. KLAUS.
- 9 Disease and Biological Stress in Pre-Hispanic Olmos: Uncovering Regional Health Variation at the Fringes of the Middle Sicán Heartland in Northern Peru (A.D. 900-1100). A.M. CUDDIHY, H.D. KLAUS, J.R. HURTUBISE, A.E. MAHENY, L. PEÑA.
- 10 Biocultural Consequences of Spanish Contact in the Lambayeque Valley region of northern Peru: Internal enamel micro-defects as indicators of early life stress. C.J. GARLAND, K.T. BROOKS, B.L. TURNER-LIVERMORE, H.D. KLAUS.
- 11 Health and the biological damage hypothesis in the Lambayeque valley: examining the consequences of early life stress in the late pre-Hispanic and Colonial periods. M.A. MAUGHAN.
- 12 Social weaning: childhood diet and health in medieval Canterbury, UK. P. MAHONEY, C. SCHMIDT, C. DETER, A. REMY, P. SLAVIN, J. MISZKIEWICZ, P. NYSTROM.
- 13 Bringing Wine to the Feast: Diet and Status of Late Iron Age and Early Roman Individuals from Winterborne Kingston, UK. S.A. MCGUIRE, H. SCHUTKOWSKI.
- 14 Child health in the early medieval community from Omev Island, western Ireland. M. NOVAK, T. O'KEEFFE.
- 15 Status and Activity in Prehistoric Central California: Patterns of Osteoarthritis in a Social Context. C.M. CHEVERKO, E.J. BARTELINK.
- 16 Dental Health in a Late Prehistoric Population from Northeastern Ohio. M.A. CLARK, L.A. TREMBLAY CRITCHER, A.M. CASADO.
- 17 Understanding the quality of health care available at the Erie County Hospital, Buffalo, New York, 1880-1910. R.L. HIGGINS, J.E. SIRIANNI, J.L. RAINES.

## Thursday Afternoon sessions

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### Session 15: **Costly and Cute: How Helpless Newborns Made Us Human**

*Invited Podium Symposium.* Chair: Karen R. Rosenberg.

Co-organizer: Wenda R. Trevathan

**Grand Ballroom D.**

Among the biological and behavioral foundations of humanness is the fact that we give birth to extremely undeveloped and dependent infants that require large investments in time and energy for 12–15 years. The consequences of this for an understanding of human evolution have often been alluded to but never fully explored. This symposium examines the constraints on gestation, birth and infancy including both the costs and benefits with regard to obstetrics, energetics, cognition, thermoregulation and locomotion. Presentation topics include: What is undeveloped about human infants and how does their developmental state compare with other primates? What is the state of neurological development of human infants in their first year of life? What factors account for the relative immaturity of human infants at birth? Contributors explore: anatomical effects on obstetrics, metabolic restraints on how long a woman can gestate a large-brained and large-bodied fetus, placental and immune factor challenges, and a premium on learning outside the womb while the brain is growing rapidly. Additional questions derive from exploring the idea that key human characteristics distinguishing us from other primates (such as our reliance on culture and alloparenting) owe a significant debt to the helpless infant. What role did the need to carry helpless infants contribute to the evolution and refinement of bipedalism? Did language emerge to facilitate contact between mothers and helpless infants? Did the need to care for vulnerable infants lead to paternal, grand-maternal and cooperative parenting? This costly developmental pattern is unprecedented among primates and relates to other distinctive aspects of our biology and behavior. We examine both the costs and benefits of giving birth to such immature offspring and propose that infant helplessness and human social and cultural adaptations evolved hand-in-hand.

1:00 Introduction. W.R. TREVATHAN, K. ROSENBERG.

1:15 Are human infants altricial? K.R. ROSENBERG, W.R. TREVATHAN.



## Thursday Afternoon Sessions

- 1:30 The “obstetric dilemma” hypothesis unraveled. H. DUNSWORTH.
- 1:45 Brains, birth, bipedalism and the mosaic evolution of the helpless human infant. J.M. DESILVA.
- 2:00 Comparative Placental Ecology at the Maternal-Fetal Interface. D.E. WILDMAN, J.N. RUTHERFORD.
- 2:15 Birth at the extremes: exploring fetal-maternal obstetric and metabolic relationships in small and large primates. M.S. PONCE DE LEÓN, C.P. ZOLLIKOFER.
- 2:30 Plastic and fantastic: postnatal developmental changes and the evolution of the human social brain. K. SEMENDEFERI, K.L. HANSON.
- 2:45 Three prehistoric evo-devo trends and their possible relationship to high-functioning autism in modern humans. D. FALK.
- 3:00 Expanding the network: Low testosterone men have multiple, diverse sources of social support. Evidence from a US nationally-representative sample. L.T. GETTLER, R.C. OKA.
- 3:15 Continued costs: postnatal maternal costs associated with breastfeeding and potential maternal strategies. E.A. QUINN.
- 3:30 In a World of Allomothers, Privileging the Mother-Infant Dyad: Intellectual and Political Challenges of Giving All Their Due in Evolutionary Narratives. J.J. MCKENNA.
- 3:45 Costlier inside or outside? The costs of baby carrying from pregnancy to weaning. C.M. WALL-SCHEFFLER.
- 4:00 Discussion: William Leonard, Northwestern University.
- 4:15 Break and posters.

**Session 16: Paleoanthropology: Early hominin evolution**

*Contributed Podium Presentations.* Chair: Michael J. Plavcan. **Grand Ballroom C.**

- 1:00 Cercopithecine forelimb locomotor adaptations: 3D geometric morphometric analysis of modern and fossil monkeys from the Hadar and Middle Ledi sites, Afar Region, Ethiopia. A.L. RECTOR.
- 1:15 New specimens of *Australopithecus anamensis* from Kanapoi, Kenya. J. PLAVCAN, C.V. WARD, F.K. MANTHI.
- 1:30 Miombo woodlands and early hominins: A comparison of carbonate stable isotope data from modern Koobi Fora and 3.97Ma Allia Bay fauna. M.M. BEASLEY, M.J. SCHOENINGER.
- 1:45 A.L. 333-105: Virtual reconstruction and 3D printing of *Australopithecus afarensis* child. A. BARASH, E. BEEN, Y. RAK.
- 2:00 Three-dimensional shape analysis of the distal femur of *Australopithecus sediba*. A.D. SYLVESTER, J.M. DESILVA, S.E. CHURCHILL, L.R. BERGER.
- 2:15 Chimpanzee bipedal gait mechanics and early hominin gait evolution. B. DEMES, N.E. THOMPSON, M.C. O'NEILL, B.R. UMBERGER.
- 2:30 Evolution of the hominin scapula and rotator cuff musculature. S. MATHEWS, M. HAEUSLER.
- 2:45 Evolutionary history of ape and human hand length proportions. S. ALMÉCJA, W.L. JUNGERS.
- 3:00 New Micro-CT Scan of the Imbedded Prefrontal of the Taung endocast. D.C. BROADFIELD, K.J. CARLSON, K.E. CHAPELLE, S.D. HURST, R.L. HOLLOWAY.
- 3:15 A reassessment of the taxonomic validity of the *Australopithecus sediba* mandibles. C.E. TERHUNE, T.B. RITZMAN, P. GUNZ, C.A. ROBINSON.
- 3:30 Reconsidering the high mandibular condyle of robust australopiths. W.L. HYLANDER.
- 3:45 Hominoid dental topography: a possible case for character displacement. M.A. BERTHAUME.
- 4:00 Break and posters.

**Session 17: Skeletal Biology: Functional morphology**

*Contributed Podium Presentations.* Chair: Daniel E. Lieberman. **Grand Ballroom E/F/G.**

- 1:00 Chewing efficiency variation with food material properties and masticatory morphology in humans. M.F. LAIRD, H. PONTZER, E.R. VOGEL.
- 1:15 3D Vertebral morphology, locomotion, and human spinal health. K.A. PLOMP, U. STRAND VIDARSDOTTIR, D. WESTON, M. COLLARD.
- 1:30 Reevaluating the relationship of the bicondylar angle to dimensions of the pelvis and femur. M.R. DARR, C.A. DAVIS.
- 1:45 A second look at the tibial arch angle and its use to reconstruct longitudinal arch height in fossil hominins. A.N. HEARD-BOOTH.
- 2:00 Balancing the body: frontal plane dynamics during locomotion. A.G. WARRENER, S. AMANULLAH, E. CASTILLO, D.E. LIEBERMAN.
- 2:15 Ontogenetic development of trabecular bone in the human postcranial skeleton. T.M. RYAN, S. SUKHDEO, B. PERCHALSKI, Z.R. HUBBELL, D.A. RAICHLEN, J.H. GOSMAN.
- 2:30 What femoral bone morphometry can tell us about the physical burden of early farmers at the advent of agriculture in the Southern Levant? H. MAY, I. HERSHKOVITZ.
- 2:45 New insights to the Neandertal obstetrical mechanics. V. MEYER.
- 3:00 Relationships between muscle architectural anatomy and the morphology of entheses in the thenar and hypothenar regions of modern humans. E. WILLIAMS-HATALA, S. HILES, K.N. RABEY.
- 3:15 Skeletal effects of physical activity differ between populations. I.J. WALLACE, S. JUDEX, B. DEMES.
- 3:30 Testing the effects of shoes on foot strength, stiffness and function. D.E. LIEBERMAN, E.R. CASTILLO, E. OTAROLA-

## Thursday Afternoon Sessions

CASTILLO, M. SANG, T. SIGEI, R. OJIAMBO, P. OKUTOYI, Y. PITSILADIS.

3:45 The biomechanics and functional anatomy of stone tool production. N.T. ROACH, E. WILLIAMS-HATALA, M.J. RAINBOW, B.G. RICHMOND.

4:00 Break and posters.

**Session 18: Genetics: Human variation**

*Contributed Podium Presentations.* Chair: Theodore G. Schurr. **Lindbergh.**

1:00 The Out of Africa expansion affected accumulation of deleterious alleles in human genomes. L.R. BOTIGUE, B.M. HENN, S. PEISCHL, I. DUPANLOUP, M. LIPATOV, B.K. MAPLES, A.R. MARTIN, M. YEE, H. CANN, M. SNYDER, L. EXCOFFIER, J.M. KIDD, C.D. BUSTAMANTE.

1:15 Analysis of cell-specific regulatory DNA reveals elevated immune specificity in genomic regions of high Neandertal ancestry. A.J. SAMS, A. MADAR, A. KEINAN.

1:30 Neanderthal and Denisova genetic affinities with contemporary humans. R.K. LOWERY, G. URIBE, E.B. JIMENEZ, M.A. WEISS, K.J. HERRERA, B.C. RICHARDSON, M. REGUEIRO, R.J. HERRERA.

1:45 Genetic Diversity and Population History in Svaneti, Northwestern Georgia. T.G. SCHURR, A. YARDUMIAN, R. SHENGELIA, L. BITADZE, D. CHITANAVA, S. LALIASHVILI, I. LALIASHVILI, A. SANDERS, A. AZZAM, V. GRONER, K. EDLESON, M. VILAR.

2:00 Genome-wide data from ancient Peruvian highlanders and the population history of South America. L. FEHREN-SCHMITZ, P. SKOGLUND, B. LLAMAS, S. LINDAUER, E. TOMASTO, S. KUZMINSKY, N. ROHLAND, S. NORDENFELT, S. MALLICK, A. COOPER, N. PATTERSON, W. HAAK, D. REICH.

2:15 Group Specific Alleles and Ascertainment Bias in Genomic Diversity Sets. S.D. NIEDEBALKI, J.C. LONG.

2:30 Mitochondrial lineages in Assyrian populations. M. SHAMOON-POUR, D. MERRIWETHER.

2:45 The origins of the Aegean palatial civilizations from a population genetic perspective. M. UNTERLÄNDER, S. KREUTZER, C. PAPAGEORGOPOULOU.

3:00 Genetic modifiers of *IVD* expression and leucine oxidation on a positively selected haplotype in East Asians. E.A. BROWN, T. CAPELLINI, M. RUVOLO, P.C. SABETI.

3:15 Y chromosome in surname samples: Insights into surname origin and frequency. F. CALAFELL, N. SOLÉ-MORATA, J. BERTRANPETIT, D. COMAS.

3:30 Evidence for assortative mating in recently admixed humans. M. AGARWAL, J.A. HODGSON.

3:45 Using coalescent simulations to understand population dynamics of the admixture process. A.J. KOEHL, J.C. LONG.

4:00 Break and posters.

**Session 19: Body Mass Estimation in Biological Anthropology**

*Invited Poster Symposium.* Chair: Christopher B. Ruff.

Co-organizer: Markku Niskanen

**Gateway Ballroom 2.**

Body mass is a key parameter in assessing many aspects of the biology and behavior of past individuals, populations and species, including phylogenetic and individual characterization, health status, paleoecology, encephalization, sexual dimorphism, social organization, and various life history variables. A number of approaches have been proposed to estimate body mass from skeletal remains, each with its own requirements, assumptions, and limitations. Researchers in different subfields of biological anthropology - primatology, paleontology, bioarchaeology, and forensics - also frequently have somewhat different aims and methodologies when reconstructing body size. The purpose of this symposium is to bring together workers from these various subfields with a common interest in this topic, in order to identify areas of overlap, general methodological issues and possible solutions, and new techniques or applications across the full spectrum of biological anthropology.

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

2:30–3:00 Even numbered poster authors present

3:00-3:30 Odd numbered poster authors present

3:30 Discussion: Brian Richmond, American Museum of Natural History.

1 Estimating body size in early primates: the case of *Archicebus* and *Teilhardina*. M. DAGOSTO, D.L. GEBO, X. NI, T. SMITH.

2 Body mass estimation in platyrrhines: Methodological considerations and fossil applications. J.M. PERRY, S.B. COOKE, L.B. HALENAR, J.A. RUNESTAD, C.B. RUFF.

3 A volumetric mass estimation technique for biological anthropology: ‘Convex hull’ scaling in modern primates and applications to fossil hominids. C.A. BRASSEY, T. O’MAHONEY, W.I. SELLERS.

4 Using Multivariate Adaptive Regression Splines (MARS) to model body mass over time. N.M. UHL, K.E. STULL.

5 African ape body mass prediction: New equations based on known-mass individuals. M. BURGESS, C.B. RUFF.

6 Geometric methods of body mass estimation in small-bodied hominins. S.E. CHURCHILL, S. SRIDHAR, N. CAMERON, C.S. WALKER.

## Thursday Afternoon Sessions

- 7 The effects of hip joint loading on body mass estimation in early hominins. C.B. RUFF.
- 8 Bone volume, skeletal weight and body mass in *Homo sapiens* and the Sima de los Huesos hominins. L. RODRIGUEZ, J. CARRETERO, R. GARCÍA-GONZÁLEZ, J. ARSUAGA.
- 9 Body Mass Estimation from Knee Dimensions in Hominins. N. SQUYRES, C. RUFF.
- 10 Estimating variance in femoral head size against body mass estimation: implications for evolution and integration. B.M. AUERBACH.
- 11 Estimating body mass from post-cranial remains: an evaluation using a large known-mass sample of modern humans. M.C. ELLIOTT, H. KURKI, D.A. WESTON, M. COLLARD.
- 12 Can we refine body mass estimations based on femoral head breadth? M. NISKANEN, C. RUFF, B. HOLT, V. SLADEK, M. BERNER, J. JUNNO, H. MAIJANEN.
- 13 Juvenile body mass estimation: Challenges, issues, and new directions. L.W. COWGILL.
- 14 The effect of age on body mass estimation using the stature/bi-iliac method. J. JUNNO, M. NISKANEN, C. RUFF, B. HOLT, V. SLADEK, M. BERNER, H. MAIJANEN.
- 15 Body Mass in Forensic Anthropology: Can it be Estimated? A. ROSS, J. ALLEYN.
- 16 Body Mass Estimation from Pelvic and Femoral Variation Among Modern British Women of Known Mass. M.B. YOUNG, K. POOLE, F. JOHANNESDOTTIR, J.T. STOCK, C.N. SHAW.
- 17 Potential caveats in body mass estimation: comparison of reported living and measured cadaver weight. H. MAIJANEN, Y. JEONG.
- 18 Testing the cylindrical model for weight reconstruction - the effects of fat mass, lean mass, and body proportions. S.T. NIINIMÄKI, M.E. NISKANEN.

**Session 20: The Bioarchaeology of Cardiovascular Disease**

*Invited Poster Symposium.* Chair: Michaela Binder.

Co-organizer: Charlotte Roberts

**Gateway Ballroom 3.**

According to the WHO (2013), cardiovascular diseases (CVDs) are the leading cause of death worldwide today. Including a wide range of heart and blood vessel disorders, they are commonly linked to factors related to modern life such as smoking, obesity, a diet high in saturated fat, but also genetic reasons. Even though CVDs represent a hallmark feature of the second epidemiological transition, occurring in most parts of the world during the 20th century, palaeopathological research on mummies and skeletal human remains is increasingly revealing evidence that CVDs have plagued humankind for a long time. These findings not only offer new information about morbidity in the past, but also allow for new insights into the evolution and aetiology of CVDs through contextualised bioarchaeological studies and biomolecular approaches. Nevertheless, evidence for CVDs in archaeological human remains is still scarce. This is particularly true for skeletal remains, linked to factors such as inadequate recovery strategies during excavation and lack of recognising evidence for CVDs, such as calcifications resulting from atherosclerosis. With new evidence emerging in recent years, it is timely for a symposium to bring together expertise in palaeopathology, forensic anthropology, biomolecular archaeology and evolutionary medicine to discuss current knowledge of CVDs in past human populations, including new research perspectives, recovery strategies, taphonomic factors, and highlight the modern relevance of the insights gained from the data. Additionally, recent analyses of burials containing skeletal remains show the potential for preservation of CVD evidence alongside skeletons, the expected 'materials' that bioarchaeologists study. This proposed symposium will lead to increasing awareness of the possibility and research potential of detecting evidence for CVDs in archaeological human remains within the bioarchaeological community, a step ultimately crucial to expanding the current dataset and allowing for wider insights into the epidemiology, history, and evolution of CVDs in the past.

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

2:30–3:00 Even numbered poster authors present

3:00-3:30 Odd numbered poster authors present

- 1:15 Discussion: Niels Lynnerup, University of Copenhagen and Albert Zink, EURAC.
  - 1 The impact of bioarchaeological study on understanding the evolution of cardiovascular disease. C.A. ROBERTS.
  - 2 Calcified structures as potential evidence of atherosclerosis associated with human skeletal remains from Amara West (1300–800BC). M. BINDER, C.A. ROBERTS.
  - 3 Differential diagnosis of a calcified object from Meroitic Al Khiday 2, Central Sudan. T. JAKOB, J.W. WALSER III.
  - 4 Survival of calcified atheromata in the archaeological record - The effect of taphonomy, excavation and curation strategies on preservation and analysis. N. LYNNERUP, C. ROBERTS, M. BINDER.
  - 5 CT scan 3D visualisation of atheromas in Egyptian mummies: potential, limitations and the need for a more systematic approach. D.M. ANTOINE, B. MORENO, J.H. TAYLOR, M. VANDENBEUSCH.
  - 6 CT Evidence of Atherosclerosis in Ancient Mummies: The Horus Study of 220 Mummies from 5 Continents. R.C. THOMPSON, A.H. ALLAM, G.P. LOMBARDI, L. WANN, M. SUTHERLAND, J.D. SUTHERLAND, A. ZINK, M. SOLIMAN, B. FROHLICH, J.M. MONGE, C.M. VALLODOLID, S.E. COX, G. EL-MAKSOU, I. BADR, M. MIYAMOTO, A. NURED-DIN, L. WATSON, D. MICHALIK, S.I. KING, J. NARULA, C.E. FINCH, G.S. THOMAS.
  - 7 The Genetic Background of Atherosclerosis in Ancient Mummies. A.R. ZINK, S. WANN, R.C. THOMPSON, A. KELLER,



## Thursday Afternoon Sessions

F. MAIXNER, A.H. ALLAM, C.E. FINCH, B. FROHLICH, G.P. LOMBARDI, M.L. SUTHERLAND, J.D. SUTHERLAND, L. WATSON, S.L. COX, M.I. MIYAMOTO, J. NARULA, A.F. STEWART, J. KRAUSE, G.S. THOMAS.

**Session 21: Beyond the Bones: Engaging with Disparate Datasets**

*Invited Poster Symposium.* Chair: Madeleine Mant.

Co-organizer: Allee Holland

**Gateway Ballroom 4.**

Anthropological investigations into questions concerning health, disease, and the life course in past and contemporary societies demand the incorporation of and engagement with diverse datasets. Tackling these ‘big picture’ questions related to human health-states requires understanding and integrating social, historical, environmental, and biological contexts. Using multiple lines of inquiry inevitably involves unpacking and uniting qualitative and quantitative data from divergent sources and technologies. The crucial interplay between new technologies and traditional approaches to anthropology necessitates innovative approaches that draw on multi and transdisciplinary collaboration that promotes the emergence of new and alternate views. In this session we will explore how current research in physical anthropology is responding to the challenges posed by disparate data. The papers presented will illustrate and promote a discussion of the problems, limitations, and benefits of drawing upon and comparing datasets, while illuminating the many ways in which anthropologists are using multiple data sources to unravel larger conceptual questions in anthropology.

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

2:30–3:00 Even numbered poster authors present

3:00-3:30 Odd numbered poster authors present

2:15 Discussion: Carlina De la Cova, University of South Carolina.

- 1 Missing, presumed dead: Deconstructing ‘high’ infant mortality with new data sets from historic cemetery populations. A.L. MURPHY.
- 2 Direct Digital Radiographic Imaging of Archaeological Skeletal Assemblages: An advantageous technique and the use of the images as a research resource. J.J. BEKVALAC.
- 3 ‘Readmitted under urgent circumstance’: uniting archives and bioarchaeology at the Royal London Hospital. M.L. MANT.
- 4 Beyond the Bones of Baikal: 18 Years of Multidisciplinary Bioarchaeological Research in Siberia. H.G. MCKENZIE, A.R. LIEVERSE.
- 5 Multifaceted data collection to interpret aetiology of joint osteoarthritis in the human skeleton. S.E. CALCE, H.K. KURKI.
- 6 Between the Lines: Interpreting Disparate Data in Castration Studies. K. REUSCH.
- 7 Hunting for pathogens: ancient DNA and the historical record. S. MARCINIAK, T. PROWSE, H.N. POINAR.
- 8 The use of linguistic data in bioarchaeological research: an example from the American Southwest. M.A. SCHILLACI, S. WICHMANN.
- 9 The present informs the past: incorporating modern clinical data into paleopathological analyses of metabolic bone disease. L. LOCKAU.
- 10 Now and then: Linking public health research to bioarchaeological methodology. C.L. KIRKPATRICK.
- 11 Uniting perception and reality in human nutrition: integration of qualitative and quantitative data to understand consumption. A. HOLLAND.

**Friday, March 27, 2015 - Morning sessions.****Session 22: Filling the Geographic Gaps in the Human Evolutionary Story**

*Invited Podium Symposium.* Chair: Sireen El Zaatari.

Co-organizers: Christopher J. Bae and Katerina Harvati

**Grand Ballroom D.**

Today, 7 billion people live on planet Earth and all its continents. For more than a century, we have been trying to retrace the evolutionary and migration steps our ancestors took and made us who we are today. Yet, our mission has been greatly complicated by having to locate and retrieve the pieces of the human story puzzle before we can completely assemble it. In search of our origin and evolution, we have explored many geographic areas, some more extensively than others. Europe is by far the most exhaustively researched continent to date. Yet, it only provides us with parts belonging to the final phase of our story. But, what about the story’s beginning in Africa with the origin of our lineage and its evolution leading to our species? And what about the parts of our story corresponding to the phases of our ancestors’ dispersals out of Africa and into Eurasia? Although we have retrieved numerous sections of our evolutionary history from Africa, the vast majority of these come from the eastern and southern parts of this continent, while large regions remain unexplored. Furthermore, we are still missing much evidence related to *Homo sapiens* and earlier hominin dispersals out of Africa and the earliest colonization of Europe and Asia. Such evidence is expected to be found in western Asia, the edges of Europe, and the Asian continent, all of which are still relatively poorly

## Friday Morning Sessions

documented. This symposium brings together researchers working on locating some of the missing pieces in geographic areas currently not well represented in prehistoric/paleoanthropological work, in order to present their latest findings. The goal of this symposium is to collect and showcase current research aiming to fill some of the gaps in our knowledge and to allow for a more complete reconstruction of our species' evolutionary story.

- 8:00 Between continuity and discontinuity: an overview of the West African Paleolithic over 200,000 years. E. HUYSECOM, B. CHEVRIER, S. SORIANO, M. RASSE, C. TRIBOLO.
- 8:15 Quantifying Hominin Ecospace to reconstruct early hominin dispersal routes. A. BRUCH, C. HERTLER, M. MÄRKER, F. SCHRENK.
- 8:30 Documenting the first steps out of Africa: New findings from Arabia. M. PETRAGLIA.
- 8:45 The archaeological signatures of Late Pleistocene populations' dynamics of archaic and modern humans in Arabia and Southwestern Asia. K. BRETZKE, N.J. CONARD.
- 9:00 The Northern Levantine corridor: the Paleolithic of Lebanon. S. EL ZAATARI.
- 9:15 Paleoanthropology in the Balkans: State of the art and challenges for future. K. HARVATI, V. TOURLOUKIS.
- 9:30 Eastern Mediterranean Communications Zone in the Pleistocene: Paleoanthropological and archaeological evidence. M. ROKSANDIC, D. MIHAILOVIĆ, B. MIHAILOVIĆ.
- 9:45 Earliest radiometric dates for stratified archaeological remains in Greece: the evidence from Kokkinopilos, NW Greece. V. TOURLOUKIS, P. KARKANAS.
- 10:00 Break.
- 10:15 The dispersal of Modern Humans in Asia: the Northern Route Revisited. B. VIOLA, N. ZWYNS.
- 10:30 Findings from renewed excavations at Azokh Cave: a Middle Pleistocene to Holocene site in the southern Caucasus. T. KING, T. COMPTON, A. ROSAS, P. ANDREWS, L. YEPISKOPOSYAN, L. ASRYAN, E. ALLUÉ, I. CÁCERES, P. DOMÍNGUEZ-ALONSO, Y. FERNÁNDEZ-JALVO, S. ANDREWS, N. MOLONEY, P. RYE, J. VAN DER MADE, J. MURRAY.
- 10:45 How to survive the glacial apocalypse: bugging out in late Pleistocene Central Asia. M. GLANTZ, A. VAN ARSDALE, S. TEMIRBEKOV.
- 11:00 Gaps in Chinese Paleoanthropology: A View from Guangxi. C.J. BAE, W. WANG, D. LI, S. BAILEY, E. LUDEMAN, J. CHEN, R.A. BENITEZ, E. GUTIERREZ.
- 11:15 Early modern humans and morphological variation in Southeast Asia: fossil evidence from Tam Pa Ling, Laos. F. DEMETER, L.L. SHACKELFORD, J. BRAGA, K. WESTAWAY, P. DURINGER, A. BACON, J. PONCHE, X. WU, T. SAYAVONGKHAMDY.
- 11:30 Modern human origins in Southeast Asia: behavioral perspectives. R. HOERMAN, R.A. BENITEZ, K. BURNS, C.J. BAE.
- 11:45 Discussion: Alison Brooks, George Washington University and Susan Antón, New York University.

**Session 23: Functional Morphology: Non-human Studies**

*Contributed Podium Presentations.* Chair: Todd C Rae. **Grand Ballroom A/B.**

- 8:00 The functional influence on trait covariance in platyrrhine mandibles. M.A. HOLMES.
- 8:15 Functional constraints of primate feeding: Modeling the effect of ligaments and TMJ morphology. J. IRIARTE-DIAZ, C.E. TERHUNE, A.B. TAYLOR, C.F. ROSS.
- 8:30 Trabecular structure of the mandibular condyle and food mechanical properties in non-human primates. S. COINER-COLLIER, R.S. SCOTT, E.R. VOGEL.
- 8:45 Biting off more than you can chew: a regional assessment of diet-induced plasticity. E.M. FRANKS, J.P. SCOLLAN, F.S. SHARIFF, J.E. SCOTT, K.R. MCABEE, M.J. RAVOSA.
- 9:00 Smaller posterior semicircular canals are associated with leaping in *Colobus*. T.C. RAE, P.M. JOHNSON, W. YANO, E. HIRASAKI.
- 9:15 Got a bone to pick? Functional implications of intracranial variation in osteoblast behavior. M.J. RAVOSA, H.E. WEISS-BILKA, M.M. MAZUR, S.S. LIU.
- 9:30 Chimpanzee skeletal muscle fibers are not super strong. M.C. O'NEILL, P.J. REISER, E. MOYER, S.G. LARSON.
- 9:45 Kinetics of below branch quadrupedal walking in primates and other mammals: implications for the evolution of specialized suspensory locomotion. M.C. GRANATOSKY, C.H. TRIPP, D. SCHMITT.
- 10:00 Break.
- 10:15 The relationship between cephalopelvic proportions and sexual dimorphism in the birth canal and non-obstetric pelvis in anthropoids. E.A. MOFFETT.
- 10:30 The effects of pregnancy on gait mechanics: interpretations of skeletal material. K.N. RABEY, M.C. GRANATOSKY, D. SCHMITT.
- 10:45 Improving gait generation in fossil primates using multigoal evolutionary robotics. W.I. SELLERS, E. HIRASAKI.
- 11:00 Do longer limbs translate into a reduced cost of transport? A study of locomotor performance and gait in the Longshanks mouse. L. SPARROW, C. ROLIAN.
- 11:15 An ill-named pair: Popliteal groove size does not indicate a high degree of popliteus muscle activity. B.J. SUMNER, S.G. LARSON, J.T. STERN JR.

## Friday Morning Sessions

- 11:30 The effects of trunk morphology on bipedal locomotion in chimpanzees (*Pan troglodytes*). N.E. THOMPSON, B. DEMES, M.C. O'NEILL, N.B. HOLOWKA, J.Z. LI.
- 11:45 Chimpanzee Foot and Ankle Joint Motion During Vertical Climbing. N.B. HOLOWKA, B. DEMES, M.C. O'NEILL, N.E. THOMPSON.

**Session 24: Bioarchaeology: Diet and Demography**

*Contributed Podium Presentations.* Chair: Holger Schutkowski. **Grand Ballroom C.**

- 8:00 Prehistoric motherhood: diet from pregnancy to baby-led weaning in the Danube Gorges Mesolithic-Neolithic. C. DE BECDELIEVRE, G. GOUDE, J. JOVANOVIĆ, E. HERRSCHER, M. LE ROY, S. ROTTIER, S. STEFANOVIĆ.
- 8:15 Variation in Infant Feeding Practices in Ancient Greece: Stable Isotope Analysis of Serial Sections of Dentin. C.S. KWOK, S. GARVIE-LOK, A. PAPATHANASIOU, M. KATZENBERG.
- 8:30 Weaning trajectories with nitrogen and hydrogen isotope ratios in calcified tissues. L.M. REYNARD, N. BURT, N. TUROSS.
- 8:45 Exploring childhood diet of survivors and non-survivors in prehistoric Tonga (c. 500 - 150 BP) using isotopic analyses. C. STANTIS, R.L. KINASTON, M.P. RICHARDS, H.R. BUCKLEY.
- 9:00 Early Childhood Health and Status in Tiwanaku Society. D.E. BLOM, E.A. SHEA, J.P. ALLEN, K.M. GOLDE.
- 9:15 Child experiences of the Great Irish Famine (1845–52): Bioarchaeological insights on the impact of institutionalization at Kilkenny Union Workhouse. J. GEBER.
- 9:30 Death in the City – Differential non-adult mortality in post-medieval London. H. SCHUTKOWSKI, L. CALDERWOOD, J. BUCKBERRY.
- 9:45 Exploring the effects of constant versus age-specific fertility rates on prehistoric population estimates. A.L. WARREN, U. BHAT, L. SATTENSPIEL, A.C. SWEDLUND, G.J. GUMERMAN.
- 10:00 Break.
- 10:15 Investigating Economic Specialization on the Central Peruvian Coast: A Reconstruction of Late Intermediate Period Ychsma Diet Using Stable Carbon and Nitrogen Isotopes. S.J. MARSTELLER, K.J. KNUDSON, N. ZOLOTOVA.
- 10:30 Diet, Mobility, and Pathology in Colonial-Period Northern Coastal Peru: Temporal and Site-Specific Variation. B.L. TURNER, H.D. KLAUS.
- 10:45 Dietary trajectories and stable isotope analyses indicate marked diversity between neighboring sites of Samtavro and Tchikantiskhedhi (Republic of Georgia, 1<sup>st</sup> – 6<sup>th</sup> c. AD). N. LANGOWSKI, V. PILBROW, A. SAGONA.
- 11:00 The precarious state of subsistence: reevaluating dental pathological lesions associated with agricultural and hunter-gatherer lifeways. K.E. MARKLEIN, C. TORRES-ROUFF, M. HUBBE.
- 11:15 Back to basics: Understanding the role of biological processes in adult skeletal age estimation. C.E. MERRITT.
- 11:30 Demographic parameters of commingled skeletal samples. J.M. ULLINGER, S.G. SHERIDAN.
- 11:45 Assessing the Life History of Potential Trophy Heads in the Middle Woodland Period: Isotopic Analysis of Human Remains from the Elizabeth Site (11PK512) in the Lower Illinois River Valley. D.S. JONES, B.L. TURNER, J.E. BUIKSTRA, G.D. KAMENOV.

**Session 25: Primate Evolution**

*Contributed Podium Presentations.* Chair: Sharon E Kessler. **Grand Ballroom E/F/G.**

- 8:00 Nail-like distal phalanges on postaxial digits is related to use of a terminal branch niche in non-primate mammals. S.A. MAIOLINO, S. HUANG, D.M. BOYER.
- 8:15 First complete, articulated hand of an adult Eocene primate with 3D preservation. D.M. BOYER, J.I. BLOCH, G.F. GUNNELL, G.S. YAPUNCICH, J.P. ALEXANDER.
- 8:30 Multiple instances of convergence in primate limb evolution. A.P. BARROS, S. MARTELLI, W.L. JUNGERS, J.B. SMAERS.
- 8:45 Nuclear genome sequences from the extinct subfossil lemurs *Palaeopropithecus ingens* and *Megaladapis edwardsi*. G. PERRY, L. KISTLER, L.R. GODFREY, B.E. CROWLEY, K.M. MULDOON, R. MALHI, S. SCHUSTER, W. MILLER, A.D. YODER, E.E. LOUIS.
- 9:00 Craniofacial pneumatization scales isometrically in extant Strepsirhini. T. KOPPE, S. PFLEIDERER, T.C. RAE.
- 9:15 Selection to outsmart the germs: The evolution of disease recognition and kin selection. S.E. KESSLER, T.R. BONNELL, C.A. CHAPMAN.
- 9:30 The mechanics of arboreal stability in squirrel monkeys (*Saimiri boliviensis*). J.W. YOUNG, B.A. CHADWELL.
- 9:45 On the relationship between visual acuity and vomeronasal function in primates. E.C. GARRETT, E.C. KIRK.
- 10:00 Break.
- 10:15 Environmental Variables Affecting Primate Species Richness in the Neotropics. J.P. SPRADLEY, B.A. WILLIAMS, R.F. KAY.
- 10:30 A phylogenetic hypothesis of fossil colobine relationships. S.L. CARNATION.
- 10:45 Variation in Functional Regulatory Sequences and Evolution of the Primate Elbow Joint. T.D. CAPELLINI, W.J. WOOD, D.M. KINGSLEY.
- 11:00 Using variation in dental microwear textures as a proxy for dietary diversity in Cercopithecidae. A.E. SHAPIRO.
- 11:15 The ecological niche of the *Morotopithecus*, with implications for hominoid evolution. L.M. MACLATCHY, J.B. ROSSIE, J.D. KINGSTON.

## Friday Morning Sessions

- 11:30 Sexual dimorphism and taxonomic diversity in hominine femora from the Miocene of Europe. D.R. BEGUN.  
 11:45 New partial cranium from an early Miocene locality at Lower Kapurtay. K.P. MCNULTY, I.O. NENGO, D.L. FOX, N.J. STEVENS, F.K. MANTHI, E.N. MBUA, D.J. PEPPE.

**Session 26: Primate Behavior**

*Contributed Podium Presentations.* Chair: Cheryl Knott. **Lindbergh.**

- 8:00 Rises in testosterone predict rises in dominance rank for male chacma baboons. S.K. PATTERSON, T.J. BERGMAN, D.L. CHENEY, R.M. SEYFARTH, J.C. BEEHNER.  
 8:15 Testosterone Mediates Loud Call Production in Gelada Males. M.E. BENITEZ, T.J. BERGMAN, J.C. BEEHNER.  
 8:30 Leadership patterns within gelada reproductive units. D.J. PAPPANO, T.J. BERGMAN, J.C. BEEHNER.  
 8:45 Hybrid howler monkeys discriminate phenotypes based on acoustic features but not temporal patterns of loud calls. D.M. KITCHEN, T.J. BERGMAN, J.W. SCHWARTZ, P.A. DIAS, D. CANALES-ESPINOSA, L. CORTES-ORTIZ.  
 9:00 Flexible responses of gorillas and chimpanzees to environmental disturbance: Implications of past and present logging. D.B. MORGAN, C. SANZ, S. STRINDBERG, J. ONONONGA, C. EYANA AYINA.  
 9:15 Early social exposure in wild chimpanzees: Mothers with sons are more gregarious than mothers with daughters. C.M. MURRAY, E.V. LONSDORF, M.A. STANTON, K.R. WELLENS, J.A. MILLER, A.E. PUSEY.  
 9:30 The most unkindest cut: genital wounding by chimpanzees. M.L. WILSON, J. COSSETTE, K. KOOPS, I. LIPENDE, E.V. LONSDORF, J.C. MITANI, J. PRUETZ, N. SIMMONS, D. TRAVIS, D.P. WATTS.  
 9:45 Sexual behavior, stress, and constraint in female choice in bonobos. K.J. BOOSE, F. WHITE, E. SQUIRES, A. MEINELT, J. SNODGRASS.  
 10:00 Break.  
 10:15 Association of immune variation with exploratory behavior and neuroendocrine responses to stress in vervet monkeys. A.J. JASINSKA, I. PANDREA, C. APETREI, L. FAIRBANKS, N. FREIMER.  
 10:30 Innate immune function and oxidative stress as measures of male quality in Cayo Santiago rhesus macaques. A.V. GEORGIEV, M.P. MUEHLENBEIN, S.P. PRALL, M. EMERY THOMPSON, D. MAESTRIPIERI.  
 10:45 Developmental shifts in rhesus macaque gaze following. A.G. ROSATI, L.R. SANTOS.  
 11:00 Mechanical properties of food items in the diet of the Sanje mangabey (*Cercocebus sanjei*). G. PAGES, C.L. EHARDT.  
 11:15 Wild female chimpanzees compete for meat. B.K. HANSEN.  
 11:30 Rank and reproductive state as predictors of female faunivory in Kasekela chimpanzees. R.C. O'MALLEY, M.A. STANTON, I.C. GILBY, E.V. LONSDORF, A. PUSEY, A.C. MARKHAM, C.M. MURRAY.  
 11:45 Infant carrying in orangutans: Implications for human evolution. C. KNOTT.

**Session 27: Multi-generational Perspectives on Human Biology and Anthropological Genetics: A Symposium in Honor of Michael H. Crawford**

*Invited HBA-AAPA Poster Symposium.* Chair: William R. Leonard.

Co-organizer: Dennis H. O'Rourke

**Gateway Ballroom 2**

Over the past 40 years, genetic approaches have infused nearly every aspect of research in our discipline; from nonhuman primate biology and behavior, to human adaptability and disease ecology, forensic analysis, and human evolutionary genetics. Such research approaches utilize genetic data from both contemporary and past populations to elucidate the origin and nature of human biological diversity. The unquestioned leader in the growth and influence of anthropological genetics is Michael H. Crawford, of the University of Kansas. From his early graduate research in primate genetics, to the early and seminal co-edited volume on *Methods and Theories in Anthropological Genetics*, through a series of additional volumes on Current Developments in Anthropological Genetics, to contemporary textbooks in the field, Michael Crawford has defined the anthropological genetics landscape for three generations of colleagues, collaborators, and students. Through his numerous field projects among indigenous and migrant populations around the world, Mike Crawford has charted the development and growth of genetic and population analyses of human variation in a myriad of social and ecological settings. He has also remained current on emerging trends in both laboratory and statistical analyses, adopting these new methods to refine the testing of anthropological hypothesis in his own research, and in his training of students and post-doctoral fellows. The presentations in this symposium reflect both the tremendous influence that Mike Crawford has had in developing and shaping anthropological genetics, and the breadth of his contributions to human population biology and biological anthropology.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

10:00-10:30 Even numbered poster authors present

10:30-11:00 Odd numbered poster authors present

- 10:30 Discussion: John Relethford, SUNY Oneonta.

- 1 Genetic boundaries of the Chibchan speaking populations of Central America based on mitochondrial DNA control region analyses. N.F. BALDI, P.E. MELTON, R. BARRANTES, M.H. CRAWFORD.
- 2 Migration and Expansion: Maternal Markers of the Garifuna. K.G. BEATY, N.F. BALDI, E.F. HERRERA PAZ, C. PHILLIPS-KRAWCZAK, M.G. CARPENTER, M.H. CRAWFORD.

## Friday Morning Sessions

- 3 Maternal lineage of pre-Hispanic Mayans from the archeological sites “El Rey” and “Palenque” . M.L. MUÑOZ, M.I. ISABEL OCHOA-LUGO, G. PÉREZ-RAMÍREZ, A. ROMANO-PACHECO, E. RAMOS, A. MARTÍNEZ-MEZA.
- 4 Current developments in anthropological genetics of the North American Arctic. M. HAYES, J. TACKNEY, J. RAFF, M. RZHETSKAYA, D.H. O’ROURKE.
- 5 Paternal genetic structure in contemporary Mennonite communities from the American Midwest. P.E. MELTON, K.G. BEATY, M. MOSHER, M.H. CRAWFORD.
- 6 SE Asian Parent/offspring trios offer insight into sex-specific patterns of DNA methylation at the leptin core promoter. M. MOSHER, M. SCHANFIELD.
- 7 Evidence for selection in human populations for Black/Dark Brown hair color using Phenotype Informative Markers. M.S. SCHANFIELD, K. GETTINGS, D. PODINI.
- 8 Placenta-specific protein 1 (PLAC1): An ancient and crucial element in placental health and development and a potential therapeutic target in uterine and ovarian cancers. E.J. DEVOR, D.A. SANTILLAN, M.K. SANTILLAN, M.J. GOODHEART, K.K. LESLIE.
- 9 Inconsistent inheritance of telomere length (TL): is offspring TL more strongly correlated with maternal or paternal TL? D.T. EISENBERG.
- 10 From Anthropological Genetics to Discovery of Genes for Complex Diseases in Human Populations: The Transdisciplinary Impact of Professor Michael H. Crawford. R. DUGGIRALA, R. ARYA, S. PUPPALA, J.T. WILLIAMS, V.S. FAROOK, J.E. CURRAN, C.P. JENKINSON, L. ALMASY, M.C. MAHANEY, A.G. COMUZZIE, S. WILLIAMS-BLANGERO, D.M. LEHMAN, J. BLANGERO.
- 11 Women who deliver twins are more likely to smoke and have high frequencies of specific SNPs: results from a sample of African-American women who delivered pre-term, low birth weight babies. H. HUANG, K.B. CLANCY, Y. ZHU, L. MADRIGAL.
- 12 Genetic variation in central obesity measures and serum uric acid in American Indians. G. CHITTOOR, K. HAACK, S. LASTON, L.G. BEST, E.T. LEE, B.V. HOWARD, J.W. MACCLUER, J.G. UMANS, S.A. COLE, V. VORUGANTI.
- 13 Reaching beyond Anthropological Genetics: Michael Crawford’s Contribution to Genetic Epidemiology. A.G. COMUZZIE, R. BASTARRACHEA.
- 14 Identifying genetic associations with central adiposity in Hispanic subgroups: the HCHS/SOL Study. A.E. JUSTICE, K. YOUNG, S.M. GOGARTEN, M. GRAFF, K.E. NORTH, C. LAURIE, C. ISASSI, C. LAURIE.
- 15 The Importance of Multi-Ethnic Genetic Studies: the Population Architecture using Genomics and Epidemiology (PAGE) Study. K.E. NORTH.
- 16 Health disparities in prostate cancer: Tumor epigenome profiling in African American vs European American men. R. RUBICZ, I.M. SHUI, S. ZHAO, J.L. WRIGHT, S. KOLB, E.A. OSTRANDER, Z. FENG, J. FAN, J.L. STANFORD.
- 17 Transethnic meta-analysis of exomic variation contributing to central adiposity. K.L. YOUNG, A.E. JUSTICE, H.M. HIGHLAND, M. GRAFF, T. KARADERI, N.L. HEARD-COSTA, D. PASKO, V. TURCOT, Y. LU, L. SOUTHAM, L.A. CUPPLES, C. LIU, C.S. FOX, T.W. WINKLER, N. GRARUP, R.A. SCOTT, M.M. MCCARTHY, K. MOHLKE, R.J. LOOS, I. BORECKI, C. LINDGREN, K.E. NORTH.
- 18 Body size and proportions among four indigenous Siberian populations: Climatic and social factors. J.J. SNODGRASS, W.R. LEONARD, L.A. TARSKAIA, T.M. KLIMOVA, V.I. FEDOROVA, M.E. BALTAKHINOVA, V.G. KRIVOSHAPKIN.
- 19 Applications of medicinal plants in the treatment of psychological disorders. R.A. HALBERSTEIN.
- 20 Spirited away: Coevolution with HepB/HepC to explain the alcoholic flusher paradox. R.R. ORTEGA, J.C. STEVENSON.

**Session 28: Kampsville: Celebrating Six Decades of Anthropological Research**

*Invited Poster Symposium.* Chair: Katie J. Zejdlik.

Co-organizer: Kathryn E.D. Kulhavy

**Gateway Ballroom 3.**

For over six decades students and scholars have come to Kampsville, Illinois in association with programs through the Center for American Archeology (CAA). Many of these individuals were already committed to careers in biological anthropology or have gone on to such careers largely as a result of their experiences in Kampsville. Located just one and a half hours drive from St. Louis, MO, Kampsville’s rich archaeological history has produced collections that have allowed insight into health, diet, ancestry, and mortuary customs of indigenous peoples as well as the methods and theory necessary for accumulation of knowledge about these various topics. Some of the most cited literature in biological archaeology is a result of the collections, training, and experience arising out of the Kampsville community of practice. Every year researchers whose roots can be traced back to tiny Kampsville, Illinois present their work at professional conferences all over the world and their contributions to the American Association of Physical Anthropology meetings have been substantial. On-going collaboration and mentorship among accomplished Kampsville alumnae/i and emerging professionals illustrates the legacy of cooperation fostered by the Kampsville Experience. This symposium highlights current research being conducted by the multiple generations of scholars who have been or are part of the Kampsville community. The breadth of research both theoretically and geographically demonstrates how this network continues to train and encourage new ideas and reassess old ones in an effort to promote the overall vitality of physical anthropology.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

10:00-10:30 Even numbered poster authors present



## Friday Morning Sessions

- 10:30-11:00 Odd numbered poster authors present
- 8:15 Introduction: Jane Buikstra, Arizona State University.
- 11:00 Discussion: Lyle Konigsberg.
- 1 From there to here: Biological distance in prehistoric West-Central Illinois. S.R. FRANKENBERG, L.W. KONIGSBERG.
  - 2 An odontometric analysis of interregional biological variation in the prehistoric Midwest. A.R. THOMPSON.
  - 3 An examination of bio-distance between Late Woodland and Mississippian individuals from the northern Mississippian hinterlands using odontometric analysis. K.J. ZEJDLIK.
  - 4 Relatedness and Social Organization at the Ray Site (11BR104): A Biological Distance Analysis of a Middle Woodland Ridge Top Cemetery in the Illinois Valley. E.A. BULLION, J.L. KING.
  - 5 Studying Mississippian Societies in the Lower Illinois Valley: What We Have Learned & What We Need to Know. L. GOLDSTEIN.
  - 6 The Bioarchaeology of Midwestern Archaic Rockshelters 30 Years Later - Revisiting Modoc Rockshelter, Randolph County, Illinois. E.A. HARGRAVE.
  - 7 From the Illinois to the Nile Valley: The Bioarchaeology of Nubia Expedition. B.J. BAKER.
  - 8 Famine and Frailty: Crisis Mortality and Stature in Medieval London. S.N. DEWITTE, S. YAUSSEY.
  - 9 Dissection and Social Inequality: the Bioarchaeology of Structural Violence. K.C. NYSTROM.
  - 10 A preliminary analysis of dental metrics from elite Mycenaean tombs at Sykia and Kalamaki, Greece. K.E. KULHAVY.
  - 11 Evidence of Fluvial Transport of Human Skeletal Remains at Actun Tunichil Muknal, Belize. C.L. HALLING, S.P. NAWROCKI, S. GIBBS.
  - 12 Digitizing Standards with OsteoSurvey: A case study in open access data collection at Deir el-Medina, Egypt. A.E. AUSTIN.
  - 13 Femur Subtrochanteric Shape and Ancestry Assessment in Modern Japanese and Thai Individuals. S.D. TALLMAN.
  - 14 Ancient DNA sequencing of a Middle Woodland variant: a discussion of the Ray Site and recent findings. E.A. NELSON, J. BUIKSTRA, J.V. PLANZ.
  - 15 Validation of a Non-destructive DNA Extraction Method Applied to Forensic Samples. D.W. STEADMAN, F.L. PACK, B.F. ALGEE-HEWITT, B.I. HULSEY, G.S. CABANA.

**Session 29: Females: Friends or Foes? New Perspectives on Female Bonds in Primates**

*Invited Poster Symposium.* Chair: Michelle A. Rodrigues.

Co-organizer: Monica L. Wakefield

**Gateway Ballroom 4.**

Socioecological models of primate sociality attribute female bonds to kinship and competitive regimes based on ecological factors. However, socioecological models are under critique due to limitations in their predictive framework. As research increases across field sites, a better understand of both inter- and intra-specific variation in social relationships has emerged. For example, females in societies considered “non-female bonded” exhibit differentiated, affiliative bonds at some sites, whereas primate species considered “female-bonded” do not always exhibit strong female bonds. Furthermore, new techniques, such as non-invasive genetic and hormone sampling and mathematical modeling and network analysis allow us to build on the traditional methods of studying female behavioral ecology. Here, we consider recent studies of female relationships across the primate order to generate ideas for new theoretical models of social bonding in female primates.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

10:00-10:30 Even numbered poster authors present

10:30-11:00 Odd numbered poster authors present

- 11:00 Discussion: Lynne Isbell, University of California, Davis.
- 1 Female friendships in a ‘non-female-bonded’ platyrrhine, *Ateles geoffroyi*. M.A. RODRIGUES.
  - 2 Effects of male social upheaval on social bonds and stress in female chacma baboons. S. CHOWDHURY, L. SWEDDELL.
  - 3 Recognizing rivals: Do female olive baboons (*Papio anubis*) forgo social bonds during periods of heightened competition? J.T. WALZ.
  - 4 You can't bogart that grass: Dominance and resources in geladas. E. TINSLEY JOHNSON, N. SNYDER-MACKLER, J.C. BEEHNER, T.J. BERGMAN.
  - 5 Dominance rank and rank disparity predict female rhesus macaque social relationships even in the absence of kin networks. N. SNYDER-MACKLER, J. KOHN, C. MOORE, Z.P. JOHNSON, M.E. WILSON, J. TUNG.
  - 6 Dietary preference, feeding behavior, and sociality among female Diana monkeys (*Cercopithecus diana*). E.E. KANE.
  - 7 Social bonds without genetic ties? A new framework for characterizing social relationships among female bonobos (*Pan paniscus*). L.R. MOSCOVICE, G. HOHMANN.
  - 8 Female chimpanzees (*Pan troglodytes schweinfurthii*) form social bonds. M.L. WAKEFIELD.
  - 9 Determinants of social preferences among female chimpanzees (*Pan troglodytes schweinfurthii*) at Gombe National Park, Tanzania. S. FOERSTER, K. MCLELLAN, K. SCHROEPFER-WALKER, C.M. MURRAY, C. KRUPENYE, I.C. GILBY, A.E. PUSEY.

## Friday, All day sessions.

### Session 30: Paleoanthropology: Hominins and Early Homo

*Contributed Poster Presentations.* Chair: Juliet K Brophy. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Lucy plus one: Intermingling of a second individual in the spinal column of A.L. 288-1. M.R. MEYER, S.A. WILLIAMS, M. SMITH, G.J. SAWYER.
- 2 Ontogenetic morphology of the cervical vertebral column in *Homo sapiens* with implications for *Australopithecus afarensis*. N. GRIDER-POTTER, T.K. NALLEY.
- 3 Adaptation to terrestrial bipedalism and 5<sup>th</sup> metatarsal structural properties in *Australopithecus* and early *Homo*. T. JASHASHVILI, K.J. CARLSON, M.R. DOWDESWELL, D. LORDKIPANIDZE.
- 4 Taxonomic identification of isolated mandibular molars in *Australopithecus afarensis*, *A. africanus*, and *Paranthropus robustus* using geometric morphometrics. C.A. ROBINSON, F.L. WILLIAMS.
- 5 Variation in lateral plantar process morphology and implications for bipedalism in *Australopithecus*. E.K. BOYLE, B. ZIPFEL, J.M. DESILVA.
- 6 Ecological niche selectivity in *Australopithecus anamensis*. L. DUMOUCHEL, F.K. MANTHI.
- 7 Principal strain orientations during biting in the faces of chimpanzees and australopiths. D.S. STRAIT, C.F. ROSS, J.A. LEDOGAR, A.L. SMITH, B. VILLMOARE, S. BENAZZI, G.W. WEBER, M.A. SPENCER, P.C. DECHOW, I.R. GROSSE, B.R. RICHMOND, B.W. WRIGHT, Q. WANG, C. BYRON, D.E. SLICE, K.J. CARLSON, D.J. DE RUITER, L.R. BERGER, K. TAMVADA, L.C. PRYOR SMITH, M.A. BERTHAUME, J. CHALK.
- 8 Bony facial buttressing in South African australopiths: a finite element analysis. J.A. LEDOGAR, S. BENAZZI, A.L. SMITH, G.W. WEBER, M.A. SPENCER, K.B. CARLSON, P.C. DECHOW, I.R. GROSSE, C.F. ROSS, B.G. RICHMOND, B.W. WRIGHT, Q. WANG, C. BYRON, D.E. SLICE, K.J. CARLSON, D.J. DE RUITER, L.R. BERGER, K. TAMVADA, L.C. PRYOR SMITH, M.A. BERTHAUME, J. CHALK, D.S. STRAIT.
- 9 The influence of cranial and postcranial integration on the evolution of hominin basicranial morphology. C.I. VILLAMIL.
- 10 A re-examination of maxillary shape variation and the attribution of Early Pleistocene fossils to the genus *Homo*. C.S. MONGLE, A. NESBITT, F.E. GRINE.
- 11 Changes to the face and basicranium in a habitually bipedal Japanese macaque (*Macaca fuscata*). R.C. MCCARTHY, L.N. BUTARIC.
- 12 Intra-specific variability in anterior and post-canine dentition in *Paranthropus robustus*. K.D. O'NEILL, A.L. RECTOR.
- 13 Reconsidering the diets of *Australopithecus africanus* and *Paranthropus robustus*. F.L. WILLIAMS, C.W. SCHMIDT, A.J. REMY.
- 14 Morphometric analyses of maxillary and mandibular first molars of Pleistocene hominins. J.K. BROPHY, D.J. DE RUITER, L.R. BERGER, S.E. CHURCHILL, P. SCHMID.
- 15 Size and scaling between teeth and jaws in genus *Homo*. S.C. ANTÓN, H.G. TABOADA, V.B. DELEON.
- 16 Investigating the impact of cranial modularity on hominin phylogenetics through Bayesian analysis of partitioned character matrices. M. DEMBO, A. MOOERS, M. COLLARD.
- 17 Estimation and comparison of the adult cranial morphology of *Australopithecus sediba* using developmental simulation. K.B. CARLSON, D.J. DE RUITER, K.P. MCNULTY, T.J. DEWITT, L.R. BERGER.
- 18 Facing the facts: Foods versus fists. A test of the Carrier and Morgan adaptive model for early hominin cranial structure. B.A. VILLMOARE, M.W. GRABOWSKI, N.T. ROACH, K.G. HATALA, E. WILLIAMS-HATALA.
- 19 Hips don't lie: A multivariate approach to hominid sex determination from the pelvis. S.R. RENNIE, M. CLEGG, J.C. OHMAN.
- 20 Comparative analysis of trabecular bone structure and orientation in South African hominin tali. A. SU, K.J. CARLSON.
- 21 Proximal tibial shaft proportions in extant hominoids and early hominins. E.E. KOZMA, T. HARRISON.
- 22 Shape analysis of the distal metatarsal articular surface in cercopithecoids, apes, and humans. P.J. FERNANDEZ, S. ALMÉJICA, B.A. PATEL, C.M. ORR, M.W. TOCHERI, W.L. JUNGERS.
- 23 A hallucal distal phalanx from Dmanisi, Georgia: Implications for early *Homo* foot biomechanics and evolution. B.A. PATEL, T. JASHASHVILI, E. TRINKAUS, R.L. SUSMAN, D. LORDKIPANIDZE.
- 24 Manual proportions in *Australopithecus*: A comparative analysis including new material from Sterkfontein. K.R. OSTROFSKY, B.G. RICHMOND.
- 25 Continuous or Pulse? Simulating Speciation and Extinction from Fauna at Plio-Pleistocene Hominin Sites. D.C. PEART, J. MCKEE.
- 26 Reassessing the Oldowan-Acheulean transition from a functional perspective. A.J. KEY, S.J. LYCETT.
- 27 Newly discovered *in situ* primates and mammals from the early Pleistocene Haasgat deposits, South Africa. J.W. ADAMS, A. OLAH, M. MCCURRY, M. TALLMAN, A.D. KEGLEY, S. POTZE, L. KGASI, A.I. HERRIES.

## Friday All Day Sessions

- 28 Agent-based modeling of hominin evolution-environment interaction. J. KINGSTON, K. BATHINA.
- 29 Synchrotron x-ray imaging and MCMC support seasonal climate reconstruction. D.R. GREEN, G.M. GREEN, A.S. COLMAN, P. TAFFOREAU, T.M. SMITH.
- 30 A Bioinformatics Pipeline for Identifying Heat Shock Protein 70 (HSP70) Gene Family Duplications in Tapeworms to Study Hominin Dietary Evolution. S.M. JOHNSON, T.X. LE, B. BOUFANA, P.S. CRAIG, G.H. PERRY.

**Session 31: Functional Skeletal Biology: Non-human Studies**

*Contributed Poster Presentations.* Chair: Christopher J Vinyard. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Different Perspectives on the Expression of Joint Kinematics Can Influence Interpretation of Fossil Evidence. T.M. GREINER, K.A. BALL.
- 2 Primitively fist-walking and the radiocarpal morphology of *Rudapithecus hungaricus*. A.C. HOLMES, D.R. BEGUN.
- 3 A preliminary analysis of the iliac trabecular architecture of *Rudapithecus hungaricus*. D. SHAPIRO, D.R. BEGUN.
- 4 Hands Up: Pedal Digit Use during Arboreal Quadrupedalism and Bipedalism in *Propithecus coquereli*. K.A. CONGDON, M.J. RAVOSA.
- 5 Hominoid humeral trochlear morphology is unrelated to suspensory locomotion. M.S. SELBY, C. LOVEJOY.
- 6 Ulnar shape and locomotion in primates. T.R. REIN, K. HARVATI, T. HARRISON.
- 7 3-D Morphometric Analysis of the Primate Elbow Joint. S.B. BOREN.
- 8 Preliminary analysis of the functional morphology of the douc langur scapulae. K. BAILEY, J.D. PAMPUSH.
- 9 Analyzing the Form and Function of the Hominoid Scapula: a Morphometric and Biomechanical Approach. T.A. PÜSCHEL, W.I. SELLERS.
- 10 Does secondary bone distribution in limb bones reflect locomotor behavior in primates? S.E. LAD, W. MCGRAW, D.J. DA EGLING.
- 11 Elastic energy storage in the Achilles tendon during running gaits. A.D. FOSTER, M.T. BUTCHER, G.A. SMITH, J.W. YOUNG.
- 12 The spatial distribution of lacuno-canalicular system within the tibial cross section shows its sensitivity to the mechanical loading. A. JINDROVÁ, J. TŮMA, V. SLÁDEK.
- 13 Ecomorphology and locomotor adaptations of small mammals: implications for habitat inferences of Shuitangba (Yunnan, China), a late Miocene hominoid-bearing site. E.K. CURTIS, D.F. SU.
- 14 Testing functional hypotheses about variation in African ape scapulae using 3D geometric morphometrics. T.L. PEARMAN, R.S. JABBOUR.
- 15 Forelimb mechanics during below-branch quadrupedalism in primates: A comparison to above-branch quadrupedalism and bimanual locomotion. C.H. TRIPP, M.C. GRANATOSKY, D. SCHMITT.
- 16 Arrangement of the foot interosseous muscles in great apes. E. HIRASAKI, M. OISHI.
- 17 Growing up woolly: Infant riding and the ontogeny of forelimb and hindlimb musculature of Humboldt's woolly monkey (*Lagothrix lagotricha*). K.A. SNOWDEN, V. BISTREKOVA, L. HAYS, W.S. WITT, M. MILLER, M.N. MUCHLINSKI, J. ORGAN, S. ABSHIRE, T. BUTTERFIELD, A.S. DEANE.
- 18 Comparison of limb bone diaphyseal cross-sectional properties in tree shrews, tree squirrels, and dwarf and mouse lemurs. J.A. RUNESTAD CONNOUR.
- 19 Adaptation of cancellous bone to habitual loading: Trabecular architecture of the artiodactyl calcaneus. D.V. KOPP.
- 20 Scapular geometry and forelimb use in four sympatric cercopithecids. N.T. DUNHAM, E.E. KANE, W. MCGRAW.
- 21 Allometric shape change in the talar articular surfaces of euarchontans. G.S. YAPUNCICH, D.M. BOYER.
- 22 Morphological Aspects of Friction Grasp and Body Size in Strepsirrhines. A.K. KINGSTON.
- 23 Quantification of the position of the flexor fibularis groove of the euarchontan talus. R. NEU, G.S. YAPUNCICH, D.M. BOYER.
- 24 Functional regions of the trunk in chimpanzees and langurs: a comparison of deep back muscles. C.E. UNDERWOOD, D.R. BOLTER, A.L. ZIHLMAN.
- 25 Morphological differences in skeletal form in wild- and captive-born Primates. L. KOHN.
- 26 Fusion of the pubic symphysis and the use of Suchey-Brooks in African apes. J. EYRE.
- 27 Estimates of fossil hominin quadriceps physiological cross sectional area from patellar dimensions. K.R. RAMIREZ, H. PONTZER.
- 28 The effect of bone length and shape on bone strength in the Longshanks mouse. M. COSMAN, H. BRITZ, C. ROLIAN.
- 29 Bundle Number, Body Mass, and Bipedality: Probing the Comparative Anatomy of the Anterior Cruciate Ligament. A.A. RUTH, M. RAGHANTI, C. LOVEJOY.
- 30 Functional Implications of Maximum Skeletal Gape in Non-Human Primates. E.E. POWELL, J.M. PERRY.
- 31 Morphological signals of stress and socioendocrinology: Comparing measures of cranial fluctuating asymmetry and second to fourth digit ratio in cercopithecids. K.S. CLARKE, M. ANDERSON, A.R. ELLER, E. SIMONS, F.J. WHITE, S.R. FROST.



## Friday All Day Sessions

- 32 Bergmann's rule in skull size of wild vs. captive *fascicularis* group macaques. J.L. ARENSON, M. ANDERSON, A.R. ELLER, E.A. SIMONS, F.J. WHITE, S.R. FROST.
- 33 Comparing methods of assessing cranial ontogeny in a known-age sample of *Macaca mulatta*. E.A. SIMONS, S.R. FROST.
- 34 Bent out of shape: Cross-sectional geometric properties of the primate zygomatic arch. H.M. EDMONDS.
- 35 What can the skeleton tell us about flanging? Hard-tissue markers of cheek flanges in *Mandrillus*. M. PETERSDORF, J.P. HIGHAM, S.A. WILLIAMS.
- 36 Functional significance of the location of the axis of rotation of the mandible. C.F. ROSS, J. IRIARTE-DIAZ, A.B. TAYLOR, C.E. TERHUNE.
- 37 Occlusopalatal Landmark Variation among Savanna Baboons Fed Different Diets. R.M. CAMPBELL, M.L. CAMPBELL, E. MUZZALL.
- 38 Functional scaling trends in the trabecular architecture of the mandibular condyle of Strepsirrhine primates. N.D. SIEGEL, M.J. RAVOSA, C.J. VINYARD.
- 39 Does food preference impact oral processing in non-human primates? C.J. VINYARD, C.L. THOMPSON, A.H. DOHERTY, N.J. ROBL.
- 40 Microindentation testing of olive colobus mandibles suggests role for phylogenetic affinity in determination of mandibular bone material properties. J.L. MASSIMIN, W.S. MCGRAW, D.J. DAEGLING.
- 41 Helium experiment and vocal physiology of the phee calls in common marmosets. T. NISHIMURA, H. KODA, I.T. TOKUDA, M. WAKITA, T. ITO.
- 42 Skeletal pathology in individually documented wild Virunga mountain gorillas. M.L. KILLOUGH, D. HUNT, A.B. ERIKSEN, T.S. STOINSKI, T.G. BROMAGE, M.R. CRANFIELD, A. MUDAKIKWA, S.C. MCFARLIN.

**Session 32: Functional Skeletal Biology: Human Studies**

*Contributed Poster Presentations.* Chair: Osbjorn M Pearson. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Osteonal repathing: A broader context for the interpretation of type II osteons and bone remodeling vasculature across development . C. MAGGIANO, I. MAGGIANO, D. COOPER.
- 2 The sum of their parts: Assessing double-zonal osteons within medieval Kulubnarti, Nubia. R.M. AUSTIN, D. MULHERN.
- 3 Regional Variation in Osteon Size at the Femoral Midshaft. T.P. GOCHA, A.M. AGNEW.
- 4 Synchrotronic three-dimensional reconstruction of cortical bone for analysis of osteonal branching and interconnectivity across age. I. MAGGIANO, J. CLEMENT, D. THOMAS, Y. CARTER, D. COOPER.
- 5 Improving Accuracy, Precision, and Efficiency in Analysis of Osteon Cross-sectional Shape. C.S. MEARS, S.M. LITTON, C.M. PHIPPEN, T.D. LANGSTON, K.E. KEENAN, J.G. SKEDROS.
- 6 Intracortical porosity of the distal radius: association with evidence of systemic remodeling . R.L. HUNTER, A.M. AGNEW.
- 7 Cortical and Trabecular Bone Structural Variation in the Human Knee Joint. S.M. SUKHDEO, T.M. RYAN.
- 8 Potential Influences on Rib Osteon Area . V.M. DOMINGUEZ, A.M. AGNEW.
- 9 Trabecular bone at the knee reflects changes in load orientation during ontogeny. B. CONNER, S. SUKHDEO, B. PERCHALSKI, D.A. RAICHLIN, J.H. GOSMAN, T.M. RYAN.
- 10 A test of bone remodeling as a response to incurred loads. M.S. DRAPEAU, É. RAGUIN, R. LAZENBY, M.A. STREETER.
- 11 Investigating the extent to which enthesal changes reflect bone remodeling at the modern human femoral midshaft. J.J. MISZKIEWICZ, T.L. KIVELL, S.H. SCHLECHT, P. MAHONEY.
- 12 Risk minimization and a late Holocene increase in mobility at Roonka Flat, South Australia: an analysis of lower limb diaphyseal shape. E.C. HILL, A.C. DURBAND, K. WALSH.
- 13 Statistical evaluation of cortical thickness maps of the humeral diaphysis: A comparison of techniques. T.G. O'MAHONEY, W.I. SELLERS, A.T. CHAMBERLAIN.
- 14 Effects of the relative position of the fibula on the cross-sectional geometric properties of the tibia. A.E. FAZLOLLAH, B.M. AUERBACH, C.N. SHAW.
- 15 A world-wide survey of humeral robusticity and midshaft shape. O.M. PEARSON, V.S. SPARACELLO.
- 16 Robusticity in the axial skeleton: An example of the rib. M. MURACH, S.H. SCHLECHT, A.M. AGNEW.
- 17 Analyzing handedness using metacarpal cross-sectional geometry in archaic human populations. S.A. HALL.
- 18 Asymmetry of the endosteal lamellar pocket and cross-sectional properties in the human second metacarpal. E. RAGUIN, M.A. STREETER, R. LAZENBY, M.S. DRAPEAU.
- 19 Signals related to the advent of walking reflected in the growth allometry of long bone cross-sectional dimensions for a sample of Central Californian Amerindian children. K.N. LE, C.E. WALL.
- 20 Does Progression Velocity Predict Heel Strike and Toe-Off? S.G. LAUTZENHEISER, P.A. KRAMER.
- 21 Effects of terrain on reconstructions of mobility patterns. E. WHITTEY, B. HOLT.
- 22 Do kinematics signal energetic optimality? Evidence from human walking studies. M.N. THETFORD.
- 23 New algorithm to determine heel strike and toe-off in walking when force detection is not available. P.A. KRAMER, S.G.

- LAUTZENHEISER.
- 24 Plantar pressure distribution patterns during carrying: Implications for inferring behavior from fossil footprints. V.C. POWELL.
- 25 Exploring the relationship between radiographic and osteologic measurements of the human os calcis. D. AGOADA, P.A. KRAMER.
- 26 Neck-Shaft Angle and Climate-Induced Body Proportions. S.L. CHILD, L.W. COWGILL.
- 27 Sacral orientation and its relationship to the sexual dimorphism of lumbar lordosis. J.F. BAILEY, C.J. SPARREY, E. BEEN, P.A. KRAMER.
- 28 Resting postures in human evolution: squatting, sitting, and the biomechanics of low back pain. K.E. JELENC, D.A. RAICHLEN.
- 29 Variation in number of vertebrae in humans. R.G. TAGUE.
- 30 Early food processing techniques and the mastication of underground storage organs (USOs). K.D. ZINK, D.E. LIEBERMAN.
- 31 Variable response of masticatory function on mandibular form. N.E. HOLTON, T.E. SOUTHARD.
- 32 Integration Magnitudes and Patterns in Human and Great Ape Mandibles. J.D. PAMPUSH, C.J. ZAMBRANO.
- 33 Facial shape in trigonocephaly: a metric and geometric morphometric assessment. J. DING, L.E. CIRILLO, A.M. MCGOUGH, R.S. JABOUR, G.D. RICHARDS.
- 34 The magnitude of covariation among regions of the human cranium. A. NESBITT, K.L. BAAB.
- 35 Morphological covariation between maxillary sinus shape and the midfacial skeleton. L.N. BUTARIC, S.D. MADDUX.
- 36 Body mass estimation in paleoanthropological and bioarchaeological contexts: validation with a known body mass modern human sample. T.E. DUNN.
- 37 Postcraniometric databank for the Robert J. Terry Collection: On-line access, data sharing, and discussion for measurement standardization. D.R. HUNT, D.L. DIMICHELE.

### Session 33: Primatology: Behaviour

*Contributed Poster Presentations.* Chair: Linda F Marchant. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Individual, Observational, and Imitation Learning in Orangutans. E.R. RENNER, F. SUBIAUL.
- 2 The effect of caller activity, proximity and habitat visibility on calling rates of grunts in western gorillas (*Gorilla gorilla*). R. SALMI, D.M. DORAN-SHEEHY.
- 3 Are terrestrial siamangs left or right handed? D. SPENCE, B. BENEFIT.
- 4 How do social dynamics influence gestural communication in *Pan*? L.W. SMITH, R.A. DELGADO, JR.
- 5 Behavioral comparisons with peers for a young adult female chimpanzee (*Pan troglodytes*) following application of sensory integration therapy. E.J. INGMANSON, T.A. MAY-BENSON, M.L. BAUMAN.
- 6 The effect of reproductive state on female-female associations in chimpanzees (*Pan troglodytes*) at Taï National Park, Côte d'Ivoire. S.R. SANFORD, C. BOESCH, R.M. STUMPF.
- 7 Group sex ratio and group size alter stress and behavior of male *Pan paniscus*. A.C. KORDEK, L.M. PORTER.
- 8 Serotonin transporter expression in the amygdala of bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*): implications for species differences in social behavior. C.D. STIMPSON, W.D. HOPKINS, J.P. TAGLIALATELA, N. BARGER, P.R. HOF, C.C. SHERWOOD.
- 9 Preliminary report on the acquisition of tool-using elements during termite gathering among chimpanzees of the Goulougo Triangle, Republic of Congo. S. MUSGRAVE, E. BELL, D. MORGAN, E. LONSDORF, C. SANZ.
- 10 Hair plucking and grooming behavior in two groups of captive bonobos (*Pan paniscus*). M. FINDLEY, L.F. MARCHANT, C.M. BRAND.
- 11 Sex and age comparisons of chimpanzee grips during feeding in Mahale Mountains National Park, Tanzania. L.F. MARCHANT, M.W. MARZKE, W.C. MCGREW, S.P. REECE.
- 12 Development of social bonds through play among captive juvenile and adult bonobos (*Pan paniscus*). L.M. MEADOR, M.L. WAKEFIELD.
- 13 Does the strength of adult relationships in pair bonded monogamous siamangs fluctuate over the long term in response to female reproductive status and/or the presence of offspring? F.G. MCCROSSIN, B.R. BENEFIT, D. SPENCE, C. TOBIN.
- 14 Exploring the Relationship Between Territory Size and Mortality From Intergroup Aggression: An Agent-Based Model. K.N. CROUSE, M.L. WILSON, C.L. LEHMAN.
- 15 Using self-directed behaviors to measure perceived predation risk in wild Olive baboons (*Papio anubis*) in Gashaka Gumti National Park, Nigeria. S.Y. FOGELSON, C. ROSS.
- 16 Female friendships in a 'non-female-bonded' cercopithecine: genetic correlates of sociality and female choice in hamadryas baboons. V. STAEBELE, L. VIGILANT, L. SWEDELL.
- 17 Baboon grooming behavior in the Kinda-chacma hybrid zone in Zambia. M.M. MCDONALD.
- 18 Falling back on natural forage when the dumpster is empty: an examination of the nutritional and mechanical properties of foods consumed by free-ranging chacma baboons (*Papio ursinus*). J.E. LOUDON, O. PAINE, J. LEICHLITER, D. CODRON, M.

## Friday All Day Sessions

## SPONHEIMER.

- 19 How does access to human food affect wild long-tailed macaques (*Macaca fascicularis*) in Singapore? C.M. RILEY, S.L. JAYASRI, B.L. KOENIG, M.D. GUMERT.
- 20 Surviving a suspected chimpanzee attack: Documentation of limb amputation in a wild *Cercopithecus* monkey. K.M. DETWILER, M. NKORANIGWA, C.K. DETWILER.
- 21 Sample condition and fecal steroids: An association between water content and assay values. J. CALIFF.
- 22 Hormonal correlates of male-juvenile interactions in long-tailed macaques (*Macaca fascicularis*). K.R. TREXLER, R.L. BOWDEN, K.G. LAMBERT, M. BARDI.
- 23 Vervet monkeys prioritize highly rewarding food sites more when competitors are present. J.A. TEICHROEB, W.D. AGUADO.
- 24 Effects of early life experience on cortisol/salivary alpha-amylase symmetry in free-ranging juvenile rhesus monkeys. L.A. PETRULLO, T.M. MANDALAYWALA, D. MAESTRIPIERI, J.P. HIGHAM.
- 25 Cheek pouch use in wild Sanje mangabeys (*Cercocebus sanjei*), Udzungwa Mountains, Tanzania. E.K. LLOYD, C.L. EHARDT.
- 26 Infant involvement in male agonistic displays in black and white colobus monkeys (*Colobus vellerosus*). S.A. FOX, P. SICOTTE.
- 27 Dominance relationships in male Nepal Gray langurs (*Semnopithecus schistaceus*). R.F. PERLMAN, C. BORRIES, A. KOENIG.
- 28 Sex differences in activity patterns between wild and captive *Cebus* and *Alouatta*. R.G. REINTS, A.L. SCHREIER.
- 29 Quasi-complex cooperative strategies of Argentine tufted capuchin monkeys. C.J. SCARRY.
- 30 Sexual dimorphism and male-male competition in blond capuchin monkey in Atlantic Forest of Brazil. A.B. MARTINS, M.M. VALENÇA-MONTENEGRO, P.O. LAROQUE, A. DI FIORE.
- 31 Differentiation of vocal repertoires in sympatric tamarins, *Saguinus imperator* and *Saguinus fuscicollis*. E.E. ROBAKIS.
- 32 The influence of diet on aggression and locomotion in *A. palliata* and *C. capucinus* in Costa Rica. N.P. PRYOR, A.L. SCHREIER.
- 33 Do marmosets use olfactory cues to identify high quality food resources? C.L. THOMPSON, C. SCHEIDEL, M. PEARSON, C.J. VINYARD.
- 34 Re-evaluation of Sexual Selection Theory for Canine Size in New World Monkeys: Implications for Pitheciine Primates. L.A. ABONDANO, E. FERNANDEZ-DUQUE, A. LINK, C.A. SCHMITT, A. DI FIORE.
- 35 Maintaining and reinforcing commitment in the pair-bonded Bolivian gray titi monkey, *Callicebus donacophilus*. K.A. DINGESS, Y. GARECA, V. SANDOVAL.
- 36 The significance of allogrooming to pair-bonded owl monkeys (*Aotus spp.*). E. TAPANES, S. EVANS.
- 37 Spatial and Temporal Dynamics Among Groups of Wild Bolivian Saddleback Tamarins (*Saguinus weddelli*). L.M. PORTER, W.M. ERB, C.L. SAIRE, L.M. HERNANI-LINEROS, E.E. VIRGIN, A. DI FIORE.
- 38 Eigencoats: A new method for the quantification and comparison of intra- and interspecific lemur pelage variation. A.N. SPRIGGS, A.D. GORDON.
- 39 Cathemerality and sleep intensity in seven captive lemur species. D. SAMSON, J. BRAY, C. NUNN.
- 40 Male dominance rank and mating success in the ring-tailed lemur (*Lemur catta*). A.D. WALKER-BOLTON, J.A. PARGA.
- 41 A hard knock life: Social interactions of adopted orphan *Lemur catta*. S.L. MEREDITH.
- 42 Lemurs Do Not Yawn Contagiously. R.B. REDDY, C. KRUPENYE, E.L. MACLEAN, B. HARE.
- 43 Venom usage, anti-predatory chemical behaviors, and responses to predators among slow lorises (*Nycticebus spp.*). N.B. GROW, W. TETI, K. NEKARIS.

**Session 34: Human Biology**

*Contributed Poster Presentations.* Chair: Kyra E Stull. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Bargaining before birth: Pregnant women show motivational calibration in response to the size of their anticipated alloparental network. E.A. PADILLA, C. KIRWIN, A.D. BLACKWELL.
- 2 Physical activity levels in women of reproductive age in rural Poland. K.M. LEE, M.P. ROGERS, A. GALBARCZYK, G. JASIENSKA, K.B. CLANCY, J.D. POLK.
- 3 Patterns of asynchrony between developmental age and chronological age in utero. K.V. FLAHERTY, M. MUSY, J. SHARPE, J.T. RICHTMEIER.
- 4 Association between culturally relevant measures of stress and telomere length. P.H. REJ, N.C. RODNEY, D.A. KERTES, S.M. SZUREK, C.C. GRAVLEE, C.J. MULLIGAN.
- 5 LINE1 DNA methylation is associated with telomere length in African American children. K. YARLAGADDA, S.S. DRURY, A.L. NON.
- 6 Adiponectin and fat soluble vitamins: A nutritional physiology and bio-demography study in four central Kansas Mennonite populations. C.E. BARRETT.
- 7 Effects of menstrual cycle phase on thermoregulation variation. E.D. APPLE, K.J. FISH, Q.L. QUELLETTE, C.M. WALL-SCHEFFLER.
- 8 Effects of perceived work stress on circadian patterns of ambulatory blood pressure variation are influenced by ethnicity among

## Friday All Day Sessions

- working women. G.D. JAMES, A.S. ALFARANO.
- 9 Longitudinal dynamics of urinary C-peptide during early peri-menopause in Toba women: A preliminary analysis. A.E. SANCILIO, R.G. BRIBIESCAS, C. VALEGGIA.
  - 10 CYP19A1 methylation: life history factors' effects on the genome. M.P. ROGERS, K.M. LEE, A. GALBARCZYK, G. JASIENSKA, R. MALHI, K.B. CLANCY.
  - 11 Testosterone, strength, and the ontogeny of the male face. C.R. HODGES-SIMEON, K.N. HANSON SOBRASKE, M. GURVEN, S.J. GAULIN.
  - 12 Frontal and Browridge Covariation in Modern Humans. S. KUO, L.L. CABO, H.M. GARVIN.
  - 13 Sex Biased Asymmetry in the Craniometric Variation of Modern South Africans. K.E. STULL, M.W. KENYHERCZ, E.N. L'ABBÉ, P. TUAMSUK, C. HULSE, E. TAYSOM.
  - 14 Morphological variability of Pleistocene Australian Aboriginal crania: an influence of cultural or biological processes. T. ENGLAND, M. HENNEBERG, D. PATE.
  - 15 Stereological analysis of age-related variation in the human superior temporal association cortex. N.L. BARGER, M.F. SHELEY, C.M. SCHUMANN.
  - 16 On the Non-Existence of Cold, Wet Air and Implications for Studies of Human Nasal Variation. T.R. YOKLEY, S.D. MADDUX.
  - 17 The Effects of Climatic Trends, Variability, and Rates of Change On Mammalian Brain Evolution. B.M. SCHILDER, R. BOBE, C.C. SHERWOOD.
  - 18 Age-related changes in human mandible shape. S. SCHLAGER, M. METZGER.
  - 19 A geometric morphometric analysis of prognathism and the gnathic index. K.M. LESCIOTTO, H.M. GARVIN.
  - 20 Analysis of visual cortical thickness, ocular volume, orbital volume and visual acuity in humans. Q.M. RIORDAN, M.P. MASTERS.
  - 21 Developmental Tradeoffs of the Dental and Skeletal Systems. A.L. RAUTMAN, H.J. EDGAR.
  - 22 A Wrinkle in Time: Allostatic Load and Senescent Decline among Elderly Japanese. R.E. LEAHY, D.E. CREWS, Y. SONE, Y. KUSANO.
  - 23 Is employment status cross-culturally associated with cognitive function among older adults: Results from the Study on global AGEing and adult health (SAGE)? T.E. GILDNER, M.A. LIEBERT, P. KOWAL, J.J. SNODGRASS.
  - 24 The gripping tale of Gantzer's muscle. J. GASSLER, Z. THROCKMORTON, E. WESTERGARD, B. MOHSENI, P. HERLING.
  - 25 Relative Clavicle Length in Modern Human Males and Females from Kellis 2, Dakhleh Oasis, Egypt. M.M. BLEUZE.
  - 26 The effect of social factors on body length proportions in Polish schoolchildren from Lower Silesia. N. NOWAK, A. GOMULA, S. KOZIEL.
  - 27 Comparing Preferred and Optimal Walking Speeds. C.M. HOVÉ, C.M. WALL-SCHEFFLER.
  - 28 Morphometrics and plantar pressure in indigenous Brazilians. K. D'AOÛT, F. NORA, P. COSTA, M. VIEIRA.
  - 29 A New Method for Estimating the Relationship Between Surface Area and Volume in the Human Body. B.E. KASABOVA, T.W. HOLLIDAY.
  - 30 Insights into trunk modularity: the relationship between lumbar vertebral dimensions and pelvic shape in recent humans and chimpanzees. E.R. MIDDLETON.
  - 31 Selection gradients and ecogeographic variance in the human post-crania. K.R. SAVELL, C.C. ROSEMAN, B.M. AUERBACH.
  - 32 Associations between socioeconomic status and obesity in low- and middle-income countries: Results from the Study on global AGEing and adult health (SAGE). M.A. LIEBERT, T.E. GILDNER, P. KOWAL, S. CHATTERJI, J. SNODGRASS.
  - 33 The rise of the obesity epidemic has come to a halt among young Swiss men. K. STAUB, F.J. RÜHLI.
  - 34 Minimal VO<sub>2</sub> of Women Walking Burdened on Gradients in Urban Environments. M.J. RUE, P.A. KRAMER.
  - 35 Human Diet and Health in the Fragmented Forests of Madagascar. J.A. FISHER, F. PETERSON, M.T. IRWIN.
  - 36 Quantitative Analysis of Drift versus Selection in Prehistoric South American Populations. B. HERRERA, M. HUBBE.
  - 37 Testing a behavioral cumulative-risk model for dysentery on a historical population: Outcomes and modern applications. R.S. LANDER.
  - 38 Tuberculosis and leprosy cross-immunity hypothesis: *in vitro* test using human immune cells. J.C. WHITE, F.A. CRESPO.

**Session 35: Paleoanthropology: Late Homo**

*Contributed Poster Presentations.* Chair: Julie J Lesnik. **Archview Ballroom.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 4:00-4:45

- 1 Can oral pathology avoidance explain human dental size reduction? S.A. LACY.
- 2 Allometry and Tooth Shape of the Lower Deciduous M2 and Permanent M1. S.E. BAILEY, S. BENAZZI, J. HUBLIN.
- 3 A geometric morphometric study of hominin mandibular variation related to speech production. S. URBAS, K. DUDAS, R.C. MCCARTHY.
- 4 Comparative morphometric analyses of a lower deciduous second molar from Qesem Cave Middle Pleistocene site (Israel). C.

## Friday All Day Sessions

- FORNAI, S. BENAZZI, A. GOPHER, R. BARKAI, R. SARIG, I. HERSHKOVITZ, G.W. WEBER.
- 5 Prehistoric use of *Ammotragus lervia* in Taforalt Cave. R.L. PEDERSEN, J. BOUZOUGGAR, N. BARTON, L. HUMPHREY, E. TURNER, C.M. WALL-SCHEFFLER.
  - 6 Evaluating ontogenetic shape variation in the mandibular ramus of *Homo sapiens* and *Homo neanderthalensis*. C.A. HEALY, C.A. ROBINSON, T.B. RITZMAN, C.E. TERHUNE.
  - 7 The use of skeletal data for interpreting dental development in fossil hominins. M. ŠEŠELJ.
  - 8 Modularity and covariation in extant human occipital growth. M.E. KARBAN, R.G. FRANCISCUS, A.D. GRASS.
  - 9 Latitude and Attitude: Eating insects in the Pleistocene and today. J.J. LESNIK.
  - 10 Cooking and sugar bioaccessibility from starch in human evolution. R.S. SCOTT, K. DEROSA, M.A. ROGERS.
  - 11 Morphology and locomotor function of the hominin pubis. M.C. FOX, L.L. SHACKELFORD.
  - 12 Gross versus net metabolic rate: Which should be used when determining the speed of the minimum cost of transport for human walking? M.J. MYERS, K.L. STEUDEL-NUMBERS, C.M. WALL-SCHEFFLER.
  - 13 Walking for warmth: a reassessment of Neanderthal locomotor inefficiency. C.J. OCOBOCK.
  - 14 Tibial loading during walking and running in Late Pleistocene humans. M. HORA, V. SLADEK.
  - 15 Comparisons of strength and predictability of Neanderthal and modern human femora under loading conditions simulating irregular steps. K.H. TAMVADA, D.S. STRAIT.
  - 16 Ecological niche reconstruction of *Homo* taxa in the Late Pleistocene. K. SCHROER.
  - 17 A new calculation of the habitable land area of Sahulland during the Last Glacial Maximum and its implications for hominin population size. J.R. GAUTNEY, T.W. HOLLIDAY.
  - 18 Radiocarbon Dating of Late Neanderthals in Southern Poland. B.A. ALEX, P. VALDE-NOWAK, D. STEFAŃSKI, E. BOARETTO.
  - 19 Liang Bua Cave (Flores) humans (aka "Homo floresiensis") exhibit individual variation and temporal change, not uniformity and stasis. R.B. ECKHARDT, S. CHAVANAVES, M. HENNEBERG.
  - 20 Probability of finding a Pleistocene Down Syndrome skeleton on Flores. M. HENNEBERG, R.B. ECKHARDT.

## Friday, Afternoon sessions.

## Session 36: The Last Link: Tarsiers

*Invited Podium Symposium.* Chair: Alfred L. Rosenberger.

Co-organizers: T.D. Smith, S. Gursky-Doyen and V.B. DeLeon

**Grand Ballroom D.**

This year marks the 100<sup>th</sup> anniversary of Gregory's naming the Tarsiiformes, a taxonomic group that has endured for at least 55 million years. Its members once comprised a large intercontinental adaptive radiation but they are now represented by a few relict archipelagic species living in South East Asia. Tarsiers have been an evolutionary enigma ever since *Tarsius* was recognized by Western science. During the 20<sup>th</sup> century, two acclaimed, seminal conferences were held to discuss the taxonomical "tarsier problem." Both advanced the science considerably. With this symposium we assemble a multidisciplinary group of scholars to update key aspects of tarsier biology, evolutionary history and conservation in light of many new developments that have occurred since the last pivotal meeting, 40 years ago – actually, during the last 5-10 years. While the focus of these earlier gatherings dwelt on the crucial question of tarsier phylogeny, our theme is much broader. It reflects research intrinsic to today's physical anthropology and primatology enterprise. Consequently, this symposium will encourage dialogue among researchers with different specialties, backgrounds and perspectives, and it is likely to foster a new round of innovation and collaboration that will impact studies of tarsiers and other primates, both living and extinct. Tarsiers are the Last Link, the last remaining – and still living – animals standing between the dominant, remarkably successful anthropoids and the lemurs and lorises whose evolution took a different trajectory. They are at the center of primate evolution. Many face a perilous future. Yet we know little about their ecology, behavior, conservation, molecular systematics, taxonomy, functional morphology, growth and development, sensory systems, paleontology and phylogenetics – all matters that will be covered in our symposium – to help secure their place in nature and promote knowledge that will contribute to understanding our own remote origins.

- 1:00 Leaps in Tarsier taxonomy: Analysis of skull variations in Tarsiidae using Geometric Morphometrics. S. COUETTE.
- 1:15 Pelage Coloration As An Adaptive Trait. S. GURSKY.
- 1:30 Testing the undersampled tarsier hypothesis. M. SHEKELLE, S. GURSKY-DOYEN, S. MERKER.
- 1:45 Fossil tarsiiforms: a tangled tree. G.F. GUNNELL.
- 2:00 Tarsiers, Omomyids, and New Postcranial Elements of *Teilhardina belgica*. D. GEBO, R. SMITH, M. DAGOSTO, T. SMITH.
- 2:15 New discoveries of fossil tarsiiform primates and their implications for anthropoid origins. K. BEARD.
- 2:30 Why have tarsiers jumped between so many branches of the primate tree? T.R. DISOTELL.
- 2:45 Changing perspectives: Ontogeny of facial orientation and eye hypertrophy in tarsiers. V.B. DELEON, T.D. SMITH, A.L.



## Friday Afternoon Sessions

ROSENBERGER.

- 3:00 Overview of Sensory Systems of Tarsius. J.H. KAAS.
- 3:15 Are Tarsiers fast or slow? A comparison of the triceps surae muscle and muscle fibers. M.N. MUCHLINSKI, T.D. SMITH, L. LI, E.L. DURHAM, A. BURROWS.
- 3:30 Tarsiers are real head turners: Morphologies related to extreme axial rotation in the cervical vertebral column. T.K. NALLEY, N. GRIDER-POTTER, J.M. ORGAN.
- 3:45 What's inside tarsier faces? A.M. BURROWS, L. LI.
- 4:00 Discussion: John G. Fleagle, Stony Brook University.
- 4:15 Break and posters.

**Session 37: Human Biology: Reproduction, health and disease***Contributed Podium Presentations.* Chair: Edward H. Hagen. **Grand Ballroom A/B.**

- 1:00 Maternal Resources, Brain Development and the Pelvic Constraint. R.D. MARTIN.
- 1:15 Female smoking prevalence and the fertility transition. E.H. HAGEN, M. GARFIELD.
- 1:30 Determinants of reproductive success in Batek hunter-gatherers in Peninsular Malaysia. T.S. KRAFT, V.V. VENKATARAMAN, I. TACEY, A. KAWAI, K.M. ENDICOTT.
- 1:45 Are Waist-Hip Ratio Preferences Adaptive? An Analysis of the Female Figure in Artwork. R. STRAND, J.H. LANGDON.
- 2:00 Effects of Parasitism on Fecundity and Life History in Human Females. A.D. BLACKWELL, M. TAMAYO, H. KAPLAN, M. GURVEN.
- 2:15 A genetic link to trade-offs between reproduction and lifespan: polymorphism of interleukin-10 gene and fertility of women. G. JASIENSKA, A. GALBARCZYK.
- 2:30 Low mineral density of a weight-bearing bone among adult women in a high fertility population. J. STIEGLITZ, B. BEHEIM, B. TRUMBLE, F. MADIMENOS, H. KAPLAN, M. GURVEN.
- 2:45 Diet and Nutritional Health Among Cassava Producing Agriculturalists of East Java. E. INDRIATI, W.R. LEONARD, A.A. MILLER.
- 3:00 Direct evidence of milk consumption from ancient human dental calculus. C. WARINNER, J. HENDY, C. SPELLER, E. CAPPELLINI, R. FISCHER, C. TRACHSEL, J. ARNEBORG, N. LYNNERUP, O. CRAIG, D.M. SWALLOW, A. FOTAKIS, R. CHRISTENSEN, J. OLSEN, A. LIEBERT, N. MONTALVA, S. FIDDYMENT, M. MACKIE, A. CANCI, A. BOUWMAN, F. RUHLI, M.P. GILBERT, M.J. COLLINS.
- 3:15 Counting Calories, Counting Culture: Considerations for Diversity and Food-Based Dietary Guidelines. M. ARCENO, B. HERRERA, J.H. COHEN.
- 3:30 Accounting for nutrient composition in human foraging decisions. C. LEONARD, J. O'CONNELL, L. VASHRO, A. HENRY.
- 3:45 Lifetime reproductive effort and oxidative stress biomarkers in postmenopausal women. A. ZIOMKIEWICZ, A. SANCILIO, A. GALBARCZYK, M. KLIMEK, G. JASIENSKA, R.G. BRIBIESCAS.
- 4:00 Break and posters.

**Session 38: Skeletal Biology: Growth and Development***Contributed Podium Presentations.* Chair: Tanya M Smith. **Grand Ballroom C.**

- 1:00 Variability Selection Hypothesis and developmental plasticity in macaques and humans. A.R. ELLER, S. COHEN, S.R. FROST, F.J. WHITE.
- 1:15 Dental Perspectives on Weaning in Living and Fossil Primates. T.M. SMITH, K. HINDE, C. AUSTIN, M. ARORA.
- 1:30 Investigating sexual differences throughout postnatal ontogeny in the craniofacial complex of human juveniles. A.D. WHEAT.
- 1:45 Human molar formation overlap. H.M. LIVERSIDGE.
- 2:00 Asymmetry in the cortical and trabecular bone of the human humerus during development. B. PERCHALSKI, A. PLACKE, S.M. SUKHDEO, C.N. SHAW, J. GOSMAN, D.A. RAICHLEN, T.M. RYAN.
- 2:15 A preliminary look into the ontogeny of femoral neck cortical bone distribution using  $\mu$ -CT. A. CLAXTON.
- 2:30 Variation in body and limb proportions between Early and Archaic Americans and the prehistoric Jomon of Japan. N. SEGUCHI, C.B. QUINTYN.
- 2:45 Articulation area, robusticity and body mass effects on age-related traits from the pubic symphysis, iliac auricular surface and acetabulum. V. CAMPANACHO, A.T. CHAMBERLAIN, P. NYSTROM, E. CUNHA.
- 3:00 Body size and shape variation among southern African Later Stone Age herder-foragers. M.E. CAMERON.
- 3:15 Moderate cold stress does not alter bone architecture in growing mice: Implications for human skeletal variation. M.J. DEVLIN, K. ALAJBEGOVIC.
- 3:30 Interpreting physical impairment in the Mississippian Period: A case study from the Holliston Mills Site, TN. K.R. KAMNIKAR, M.K. ZUCKERMAN, N.P. HERRMANN, J.D. FRANKLIN.
- 3:45 Structural Resilience: Thoracic Morphology and The Body's Reaction to Long-term Corseting. R. GIBSON.
- 4:00 Break and posters.

**Session 39: Paleoanthropology: Genus Homo***Contributed Podium Presentations.* Chair: Mark W Grabowski. **Grand Ballroom E/F/G.**

## Friday Afternoon Sessions

- 1:00 The relative importance of adaptation versus genetic drift in driving diversification in *Homo*. L. SCHROEDER, R.R. ACKERMANN.
- 1:15 Did an increase in body size play a role in the origin of *Homo*? M.W. GRABOWSKI, K.G. HATALA, W.L. JUNGERS, B.G. RICHMOND.
- 1:30 What can footprint assemblages tell us about early hominin habitat preferences and social behavior? B.G. RICHMOND, N.T. ROACH, K.G. HATALA, K. OSTROFSKY, A.K. BEHRENSMEYER, R. BOBE, D.R. BRAUN, J. REEVES, P. KIURA, B. VILMOARE.
- 1:45 Cortical structure of hallux metatarsals and inferring foot loading in early *Homo*. K.J. CARLSON, T. JASHASHVILI, M.R. DOWDESWELL, D. LORDKIPANIDZE.
- 2:00 Earliest direct evidence of modern human-like foot function from 1.5 Ma hominin footprints at Ileret, Kenya. K.G. HATALA, B.G. RICHMOND.
- 2:15 New hominin fossils from Ileret (Kolom Odiet), Kenya. W.L. JUNGERS, F.E. GRINE, M.G. LEAKEY, L. LEAKEY, F. BROWN, D. YANG, M.W. TOCHERI.
- 2:30 Late Pliocene to Late Pleistocene paleoenvironments in southwestern Kenya from carbon isotopes in herbivore tooth enamel. S.A. BLUMENTHAL, T.W. PLUMMER, T.E. CERLING, P.W. DITCHFIELD, L.C. BISHOP, J. TYLER FAITH, C.A. TRYON, D.J. PEPPE, E.J. BEVERLY, R. POTTS.
- 2:45 A large 1.5 million-year-old hominin radius from Koobi Fora, Kenya. C.V. WARD, I.J. WALLACE, B.A. PATEL, J. PLAVCAN, F.M. KIRERA.
- 3:00 A new early modern human calvarium from Olduvai Gorge, Tanzania. W.B. REINER, L.J. HLUKSKO, F.T. MASAO, A. SONGITA.
- 3:15 The phylogenetic utility of mentum osseum morphology in Pleistocene *Homo*. J.E. SCOTT.
- 3:30 A re-evaluation of the Down syndrome diagnosis for LB1 (*Homo floresiensis*). K.L. BAAB, D. FALK, P. BROWN, J.T. RICHTSMIEIER, K. MCNULTY, C.F. HILDEBOLT, F.W. PRIOR, K.E. SMITH, W. JUNGERS.
- 3:45 Leanderthal Remix: a virtual reconstruction of a remarkably complete skull from the Paleoindian period of central Texas (~10,000 BP) using high-resolution X-ray CT. C.A. DAVIS, J. KAPPELMAN, A. WITZEL.
- 4:00 Break and posters.

**Session 40: Forensic and bioarchaeological perspectives on biological distance**

*Invited Poster Symposium.* Chair: Marin A. Pilloud.

Co-organizer: Joseph T. Hefner

**Gateway Ballroom 2.**

The visibility of biological distance, or biodistance, analyses in anthropology has greatly increased over the past several decades. As this type of research seeks to explore relationships between populations and individuals it can traverse sub-disciplines; therefore, these studies routinely serve as the basis of research in forensic anthropology, bioarchaeology, and paleoanthropology. The popularity of these studies is most evident in the volume of manuscripts, theses, and dissertations utilizing these analytical methods. The availability of new statistical programs and novel statistical methods, as well as the analytical complexity resulting from the inclusion of genetic models to explain relationships between individuals or groups, have greatly changed the approach to biodistance studies. However, despite advances in the field, many studies continue to rely on outdated methods of analysis. As a result, there is currently no consensus on which data types are most appropriate, which statistical models should be used, or how best to interpret the results of an analysis. Consequently, there is a marked need for a forum in which to discuss biodistance studies in a comprehensive and cohesive manner. The goal of this symposium is to synthesize previous work within the realm of biological distance analysis while highlighting current research and future directions. Scholars engaged in research focusing on population variation within anthropology in both the medicolegal and archaeological realms have been invited to participate in an effort to codify an approach to biological distance analysis. The strength of this symposium is its application to forensic, bioarchaeological, and paleoanthropological research through the evaluation of biological distance approaches in both populations and individuals. Within this symposium scholars highlight topics such as the applicability of various datasets, methodological considerations, and statistical approaches. Presentations also include case studies illustrating recent advances in the study of biodistance.

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

2:30–3:00 Even numbered poster authors present

3:00–3:30 Odd numbered poster authors present

3:30 Discussion: Jane Buikstra, Arizona State University.

1 Biological distance analysis: An analytical history of methods. J.T. HEFNER, M.A. PILLOUD.

2 Biological distances and population genetics in bioarchaeology. J.H. RELETFORD.

3 Missing data imputation methods and their performance with biodistance analyses. M.W. KENYHERCZ, N.V. PASSALACQUA.

4 A multi-tiered comparison of craniometric and molecular distances: A test case using specimens from the Norris Farms #36 archeological cemetery site. H.F. SMITH, B.I. HULSEY, F.L. PACK, G.S. CABANA.

5 Forensic Classification and Biodistance in the 21st Century: Why the Machines Will Win. S.D. OUSLEY.

6 Who were they really? Model-free and model-bound dental nonmetric analyses to affirm “known” population affiliations of seven



## Friday Afternoon Sessions

South African “Bantu” samples. J.D. IRISH.

- 7 Forensic ancestry assessment using cranial nonmetric traits traditionally applied to biological distance studies. C.M. PINK.
- 8 A Baffling Convergence: Tooth Crown and Root Morphology in Europe and New Guinea. G. SCOTT, R. SCHOMBERG.
- 9 Betwixt and Between: Central Asians and the Eurodont-Sinodont Dental Complexes. K.N. HEIM, C.A. MAIER, G. SCOTT, M.A. PILLOUD.
- 10 Reexamining postmarital residence in prehistoric West-Central Illinois. L.W. KONIGSBERG, S.R. FRANKENBERG.
- 11 Biodistance analysis of US/Mexico migrants. M. SPRADLEY.
- 12 Dominance in dental morphological traits: Implications for biological distance studies. H.J. EDGAR, S.D. OUSLEY.
- 13 Is there structure in the Euro-American population?: Evidence from cranial morphology. R.L. JANTZ, L.M. JANTZ.
- 14 Evaluating the differential impact of diet and environmental factors on the shape of different cranial regions: perspectives for reconstructing modern human dispersals. M. GALLAND, J. CORNY, M. FRIESS, R. PINHASI.
- 15 Cranial shape and the transition to agriculture. O. CHERONET, J.A. FINARELLI, R. PINHASI.

**Session 41: Embodying Impairment: Towards a Bioarchaeology of Disability**

*Invited Poster Symposium.* Chair: Jennifer L. Muller

Co-organizers: Jennifer F. Byrnes and Jonathan D. Bethard.

**Gateway Ballroom 3.**

Human societies have identified, understood, and responded to physical and mental impairments in myriad ways. According to the modern medical model, impairments result in disability. In contrast, many social theorists argue that disability is a constructed identity - a social model that hinges on environmental barriers, both physical and social. More recently, new models such as the interactional model address the complex relationships among impairment, disability, and identity. This model complicates the interconnections between impairment (body) and disability (socio-cultural), and asserts that the latter cannot be defined without the former. Ostensibly irrefutable evidence of the social construction of disability exists in the form of diverse cultural reactions to similar impairments, ranging from the assignment of disability to alternate ability. The experience of impairment often intersects with other embodied identities to create a new and dynamic social identity. Embracing a cross-disciplinary lens, this session explores a diverse array of perspectives for understanding disability and impairment in the past. The discussion of current disability theories, methods, and practices across the disciplines is placed within larger schema to pave the way for bioarchaeological discourse. Different avenues of evidence as they manifest in the documentary, ethnographic, archaeological and biological records are presented. The neglected study of disability in the past can further our anthropological focus and awareness of human culture and more specifically, human behavioral responses to impairment. There is also an emphasis on differential health, lifestyle, and attitudes towards disability and impairment cross-culturally and through time.

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

2:30–3:00 Even numbered poster authors present

3:00-3:30 Odd numbered poster authors present

- 3:30 Discussion: Russell Shuttleworth, Deakin University and Katherine Dettwyler, University of Delaware.
  - 1 Questioning Disability: Physical Impairment, Disabled Identities and Deviant Burial in Late Roman Britain. W.A. SOUTHWELL-WRIGHT.
  - 2 Differently Able?: Africanisms, Disability, and Power in the Age of Atlantic Slavery. J. BARCLAY.
  - 3 Kojo’s (Dis)ability: Interpreting Impairment in an 18th Century Jamaican Maroon Community. D.A. INGLEMAN.
  - 4 Anglo-Saxon concepts of dis/ability: placing disease at Great Chesterford in its wider context. S. MAYS, S.R. ZAKRZEWSKI, S.A. INSKIP, S. WRIGHT, J.R. SOFAER.
  - 5 Rendered "unfit": Impairment, disability and the children of the Erie County Poorhouse. J.L. MULLER.
  - 6 Quantifying impairment and disability in bioarchaeological assemblages. A.L. STODDER.
  - 7 Using Population Health Constructs to Explore Disability in Bioarchaeology. J.L. YOUNG, E. LEMAIRE.
  - 8 Injuries, Impairments, and Intersecting Identities: The Poor in Buffalo, NY, 1851-1913. J.F. BYRNES.
  - 9 Distinguishing impairment from disability in the bioarchaeological record: An example from DeArmond mound (40RE12) in east Tennessee. J.D. BETHARD, E.A. DIGANGI, L.P. SULLIVAN.
  - 10 Disability, care, and identity in the Middle Woodland period: Life at the juncture of achondroplasia, pregnancy, and treponematosi. A.A. CORMIER.
  - 11 The Identification of Traumatic Brain Injury (TBI) and Disability: Exploring Adult English Medieval Populations (1066AD - 1600AD). J. PEACOCK.

**Session 42: Contributions in honor of Tab Rasmussen**

*Special Poster Presentations.* Chair: Kathleen Muldoon. **Gateway Ballroom 4.**

12:30 – 1:00 p.m. Poster set-up. 5:45 – 6:00 p.m. Poster take-down.

- 1 Sociality of feeding and foraging in mantled howler monkeys, *Alouatta palliata*. M.A. WILKINS.
- 2 New insight into the paleoenvironment and mechanisms of taphonomic accumulation at Buluk, early Miocene, Kenya. E.R. MILLER, R.T. WATKINS, I. NENGO.
- 3 Faunal diversity in the late Oligocene Nsungwe Formation, Rukwa Rift Basin, southwestern Tanzania. N.J. STEVENS, E.R.

## Friday Afternoon Sessions

- SEIFFERT, E.M. ROBERTS, P.M. O'CONNOR.
- 4 Reconstruction of the morphology, distribution and role of *Cryptoprocta spelea* as a predator of extinct lemurs. L.R. MEADOR, J. RAKOTONDRAMAVO, L. RANIVOHARIMANANA, L.R. GODFREY.
  - 5 Seasonality and Modern Human Foraging Behaviors in the MSA of Northwest Ethiopia. B.A. NACHMAN, N.J. TABOR, J. KAPPELMAN, L.C. TODD.
  - 6 Eastern African carnivore guilds through time: integrating birds with hominins and carnivorans. M.E. LEWIS.
  - 7 Presence of nocturnal primates in disturbed forest fragments of northern Madagascar. B.Z. FREED, M.J. BROUGHTON.
  - 8 Additional Primate Fossils from the Uinta Formation, Uinta Basin, Utah. K.B. TOWNSEND, R.H. DUNN.
  - 9 Biological and environmental determinants of extinction risk: a comparative study of lemurs and marsupials. K.M. MULDOON, J.M. KAMILAR, M.B. BLANCO, L.R. GODFREY.
  - 10 Comparative ranging patterns of sympatric langurs in a dry forest in Sri Lanka. R.P. VANDERCONE.
  - 11 Discriminating tarsier acoustic forms from Sulawesi's northern peninsula. Y. YI, M. SHEKELLE, Y. JANG, J.C. CHOE.
  - 12 20 years of research on Asia's slow and slender lorises – patterns, processes and conservation priorities. K.A. NEKARIS.

## Saturday, March 28, 2015 - Morning sessions.

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### Session 43: The future of the Middle Pleistocene: New evidence from the Sima de los Huesos (Sierra de Atapuerca, Spain)

*Invited Podium Symposium.* Chair: Rolf M. Quam.

Co-organizer: Juan Luis Arsuaga

**Grand Ballroom C.**

The Middle Pleistocene time period is characterized by considerable debate among researchers, with taxonomic and phylogenetic questions centering around evolutionary relationships between European and African fossils and the origins of both the Neandertals and modern humans. Nevertheless, these debates have been hampered by a widely-scattered and poorly-dated hominin fossil record. The current symposium focuses on the evidence from the large fossil assemblage from the Sima de los Huesos in the Sierra de Atapuerca in northern Spain and addresses a number of the most relevant issues regarding fossil hominin morphology, taxonomy and phylogenetic relationships during this time period. This site offers the unique opportunity to study the skeletal remains of a single, well-dated and contemporaneous Pleistocene population and, importantly, provides critical evidence from both the skull and the postcranial skeleton. An argument is made that this collection is critical for understanding and clarifying the course of human evolution in Europe during this time period.

- 8:00 Geological and taphonomic aspects of the Sima de los Huesos site. N. SALA, A. ARANBURU, J. ARSUAGA.
- 8:15 Metric analysis of the Sima de los Huesos crania. A. PANTOJA-PÉREZ, I. MARTÍNEZ, J. ARSUAGA.
- 8:30 Estimation of the endocranial capacity of the Sima de los Huesos hominins. E. POZA-REY, J. ARSUAGA.
- 8:45 The phylogenetic position of *Homo heidelbergensis*. Y. RAK, W.L. HYLANDER.
- 9:00 Dental remains from the Sima de los Huesos. M. MARTINÓN-TORRES, J. BERMÚDEZ DE CASTRO.
- 9:15 The vertebral column and thorax in the Middle Pleistocene: the case of the Sima de los Huesos. A. GÓMEZ-OLIVENCIA, J. ARSUAGA.
- 9:30 An overall picture of the pelvis of the hominins from the Middle Pleistocene Sima de los Huesos site (Spain). A. BONMATÍ, J. ARSUAGA.
- 9:45 Ontogenetic aspects of the femur from the Sima de los Huesos site (Sierra de Atapuerca, Burgos, Spain). R. GARCÍA-GONZÁLEZ, J. CARRETERO, L. RODRÍGUEZ, J. ARSUAGA.
- 10:00 Break.
- 10:15 Two feet from the same individual from the Middle Pleistocene site of Sima de los Huesos. A. PABLOS, C. LORENZO, J. ARSUAGA.
- 10:30 Estimated body parameters of the Sima de los Huesos hominins. J. CARRETERO, L. RODRIGUEZ, R. GARCÍA-GONZÁLEZ, J. ARSUAGA.
- 10:45 Phylogenetic analysis of the Sima de los Huesos hominins and evolutionary patterns in the Middle Pleistocene. J. ARSUAGA, I. MARTÍNEZ, A. GRACIA-TELLEZ, R.M. QUAM.
- 11:00 Neandertal / Modern Human Lineage Divergence Time. J. HUBLIN.
- 11:15 Discussion: Erik Trinkaus, Washington University.

### Session 44: Rethinking Racial Health Disparities: The genetic anthropologist's contribution to debates over health inequalities

*Invited AAAG-AAPA Podium Symposium.* Chair: Abigail W. Bigham.

Co-organizer: Amy Non

**Grand Ballroom D.**

Race has been a central research focus in Biological Anthropology over the past century, with various scientists disagreeing about its existence as a biologically based concept. In the 1960's, Frank Livingstone observed, "There are no races, there are only clines". Today, new technologies and larger global datasets provide data on genetic and phenotypic diversity that present a more detailed understanding of the distribution of human genetic variation. These data demonstrate that human biological variation is real and racial inequalities in health status persist. For example, in the US and throughout the world, there are dramatic disease inequalities between racially defined groups ranging from cardiovascular disease to cancer. Some researchers argue that these disparities are genetically based (and continue to search for pharmacogenetic solutions), while others focus on extrasomatic variables contributing to these inequalities. Anthropologists can offer valuable insight into this debate by providing a more integrated understanding of how these factors contribute to the origins and persistence of racial health disparities. This symposium will bring together anthropological researchers who have made important contributions to the study of human genetic variation and who have provided critical insights into the debate. We hope that this symposium sheds light on the key factors underlying racial health disparities, highlights opportunities for diminishing them, and provides productive avenues for future research.

- 8:00 Operationalizing Race, Resisting Racism: bridging biological, political, and lived experiences." G.A. TORRES, J.P. BENN TORRES.
- 8:15 Population structure beyond that detected using model-based clustering. J.C. LONG, J.M. GROSS, A.J. KOEHL, S.D. NIEDBALSKI.
- 8:30 Improving access to socioeconomic data for genetic studies of racial health disparities. B.M. HOLLISTER, E. FARBER-EGER, D. CRAWFORD, M.C. ALDRICH, A. NON.
- 8:45 Developmental and epigenetic responses to the environment: mechanisms for the embodiment of health disparities in New Zealand. Z.M. THAYER, C.W. KUZAWA.
- 9:00 Cultural meaning, social structure, and the health effects of systemic racism: The HEAT Heart Health study. C.C. GRAVLEE, S.M. SZUREK, C. MCCARTY, C.J. MULLIGAN.
- 9:15 Interdisciplinary anthropology approaches to health disparities research: sociocultural and genetic contributions to variation in blood pressure among African Americans in the Health Equity Alliance Tallahassee (HEAT) Heart Health study. L.N. PEARSON, S.M. SZUREK, C.C. GRAVLEE, C.J. MULLIGAN.
- 9:30 Genetic influences on Health: Does race matter? M.J. BAMSHAD.
- 9:45 Race, Genetic Ancestry, Biomedical Research, and the Politics of Trust. R.A. KITTLES.
- 10:00 Break.
- 10:15 Development of culturally relevant measures of stress and social support among Mexican immigrant families. A.L. NON.
- 10:30 Tanning persistence is associated with Indigenous American ancestry in Mexican Americans. E.E. QUILLEN, M.D. SHRIVER.
- 10:45 Integrating anthropological perspectives on race, human genetic variation, and health disparities in medical education. D.A. BOLNICK.
- 11:00 Mitigating health disparities: a human rights imperative and the role of anthropological geneticists. J.K. WAGNER.
- 11:15 Implications of the apportionment of human genetic diversity for the apportionment of human phenotypic diversity. M.D. EDGE, N.A. ROSENBERG.
- 11:30 Genetics, geocoding, and electronic health records: Health inequalities and genomewide association studies of metabolic and gastrointestinal diseases. A.N. KHO, K.L. JACKSON, J.J. BEHRENS, J. PACHECO, L.L. ARMSTRONG, M. HAYES.
- 11:45 Discussion: Milford Wolpoff, University of Michigan and Connie Mulligan, University of Florida.

**Session 45: Primatology: Ecology and Conservation**

*Contributed Podium Presentations.* Chair: Christopher A Shaffer. **Grand Ballroom A/B.**

- 8:00 Joint network modeling: Describing interdependence across behavioral networks to elucidate social stability. B.A. BEISNER, F. HSIEH, B. MCCOWAN.
- 8:15 Cost-based phylogenetically-controlled analysis of signal tradeoffs in primate-dispersed fruits. K. VALENTA, K.A. BROWN, A.D. MELIN, S.K. MONCKTON, S.A. STYLER, D.A. JACKSON, C.A. CHAPMAN.
- 8:30 Mixed Species Associations in Guianan bearded sakis (*Chiropotes sagulatus*) in Guyana. C.A. SHAFFER.
- 8:45 The Tana River red colobus (*Procolobus rufomitatus*) exhibit behavioral flexibility to changes in habitat quality; a longitudinal and spatial comparison of behavioral ecology. L.C. LOYOLA, R.A. DELGADO.
- 9:00 Vulnerability to novel and zoonotic pathogens in Nigerian red-capped mangabeys. S. FRIANT, T.L. GOLDBERG.
- 9:15 Local and global climate effects on white-faced capuchin population growth and demography. F.A. CAMPOS, K.M. JACK, L.M. FEDIGAN.
- 9:30 Energetic effects on the long calls of adult male Bornean orangutans (*Pongo pygmaeus wurmbii*). W.M. ERB, M.A. VAN NOORDWIJK, T. MITRA-SETIA, T.D. BRANSFORD, B. SPILLMAN, L.P. DUNKEL, M. EMERY-THOMPSON, E.R. VOGEL.
- 9:45 Dietary Ethanol Ingestion by Free-ranging Spider Monkeys (*Ateles geoffroyi*): An Examination of the 'Drunken Monkey' Hypothesis. V.R. WEAVER, R. DUDLEY, C.J. CAMPBELL.
- 10:00 Break.
- 10:15 Morphological convergence in the pelvis of slow-moving sloths and lorises. K.L. LEWTON.

## Saturday Morning Sessions

- 10:30 Tropical research is biased towards national parks containing great apes. A.J. MARSHALL, E. MEIJAARD, E. VAN CLEAVE, D. SHEIL.
- 10:45 Who hunts lemurs and why do they hunt them? C. BORGERSON, M.A. MCKEAN, L.R. GODFREY.
- 11:00 Mummified baboons clarify ancient Red Sea trade routes. N.J. DOMINY, S. IKRAM, G.L. MORITZ, J.N. CHRISTENSEN, P.V. WHEATLEY, J.W. CHIPMAN.

**Session 46: Paleoneurology**

*Contributed Podium Presentations.* Chair: Shawn Hurst. **Grand Ballroom A/B.**

- 11:15 The New and Old in Hominid Brain Evolution: Why Paleoneurology Needs the Lunate Sulcus. R.L. HOLLOWAY, S.D. HURST, D.C. BROADFIELD, T. SCHOENEMANN.
- 11:30 The New and the Old in Hominid Brain Evolution, Part II: Why Paleoneurology Needs A Chimpanzee Brain Atlas. S.D. HURST, R.L. HOLLOWAY, T. SCHOENEMANN, D.C. BROADFIELD, K.D. HUNT.
- 11:45 Estimated total time spent in social play prior to adulthood is strongly associated with brain size in primates. P. SCHOENEMANN.

**Session 47: Human Biology: Adaptation**

*Contributed Podium Presentations.* Chair: Kate Clancy. **Grand Ballroom E/F/G.**

- 8:00 Old Boys Club Starts Early: A Network Analysis of Peer Perception in Undergraduate Classrooms. D.Z. GRUNSPAN, S.L. EDDY, S.M. GOODREAU.
- 8:15 Let's talk about race, maybe: Teaching about identity as a tool to engage future scientists. K.B. CLANCY, C.D. HUNTER.
- 8:30 Secular changes in height among Polish schoolchildren within the socio-economic context: during the communism, political transition and capitalism, 1966-2012. A. GOMULA, S. KOZIEL, N. NOWAK.
- 8:45 Social variation of menarcheal age between 1966 and 2012 in Polish girls. S. KOZIEL, N. NOWAK, A. GOMULA.
- 9:00 The Changing Spatial Pattern of Low and Very Low Birthweight in the United States, 1972-2008. J.H. JONES, P.T. LABO.
- 9:15 Reconstructing the impact of infectious diseases on the immune system of human populations: periodontal disease as marker to detect immunological shifts? C.K. KLAES, M.B. LAWRENZ, S.N. DEWITTE, F.A. CRESPO.
- 9:30 Inflammation, parasite load, socioenvironmental factors and metabolic syndrome on the island of Utila, Honduras. A. GARCIA, A. BLACKWELL.
- 10:00 Break.

**Session 48: Skeletal Biology: Dentition and Diet**

*Contributed Podium Presentations.* Chair: Patricia M Lambert. **Grand Ballroom E/F/G.**

- 10:15 Life on the Santa Barbara Channel Islands, ca. 9,500 B.P.: Insights from the Dentition of Tuqan Man. P.M. LAMBERT, S.B. SHOLTS, J.M. ERLANDSON.
- 10:30 Scanning electronic microscopy analysis on intentionally modified teeth. E. JOHANNESDOTTIR, K. ROBSON-BROWN.
- 10:45 The Timing of Childhood Metabolic Stress: Initial Perspectives From Incremental Microstructures of Tooth Enamel in Lambayeque, Peru. H.D. KLAUS, D.H. TEMPLE, K. BAUER, C. MERCHANT.
- 11:00 Identifying biological relatives in a deciduous dental sample: bioarchaeological implications. K.S. PAUL, C.M. STOJANOWSKI.
- 11:15 Bioarchaeological evidence physiological for trade offs in response to early-life stress among Late/Final Jomon period foragers. D.H. TEMPLE.
- 11:30 Can cephalometrics discriminate between the sexes in a diverse juvenile sample? A. O'DONNELL, S. DANESHVARI.
- 11:45 Kennewick Man: paleodiet, and the people of the Pacific Northwest Coast. H.P. SCHWARCZ, T. STAFFORD, JR., B.S. CHISHOLM, M. BURCHELL, M. KNYF, D.W. OWSLEY.

**Session 49: Engaging Research Communities: Collaborating and Translating Research in Biological Anthropology**

*Invited Poster Symposium.* Chair: Felicia C. Madimenos.

Co-organizer: Michel Waller

**Archview Ballroom.**

The field of biological anthropology inherently involves researcher interaction with human, ancestral hominin, and non-human primate communities/populations in order to address questions pertinent to our specific subareas. An essential, though often tangential component to conducting research with/in any community, involves the process of including and engaging the local populations in study regions while translating and disseminating research findings in an accessible and sustainable way. While these modes of engagement will be undoubtedly regionally, culturally, and community-specific, there is nonetheless minimal discussion among biological anthropologists regarding outreach and how we have enhanced participant/community agency and translated scientific knowledge in our research sites. This symposium provides a forum for researchers across subdisciplines to present on the creative ways they have engaged the research communities they work in/with and furthermore, shaped opportunities that potentially empower communities to participate in and affect decisions about the research process and future research directions.

## Saturday Morning Sessions

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.  
8:00-8:45 Authors present (engaging research communities)  
Discussion 8:45-9:15

- 8:45 Discussion: Leslie Aiello, Wenner-Gren Foundation for Anthropological Research.
- 1 The Maya Project: Engaging Maya communities and the general public in research through art and multimedia outputs. M. VARELA-SILVA, B. BOGIN, H. AZCORRA, M. AVILA, M. CASTILLO, S. RICHARDSON, F. DICKINSON.
  - 2 Accomplishing broader impact through secondary school teacher workshops in Arusha, Tanzania. L.J. HLUSKO, W.B. REINER, J.K. NJAU, F.F. MANGALU.
  - 3 Local people and the ethics and economics of habituating primates. M.T. WALLER, F.J. WHITE.
  - 4 Shuar Health and Life History Project: Varieties of collaborative research and the translation of scientific research in Amazonian Ecuador. F.C. MADIMENOS, L.S. SUGIYAMA.
  - 5 Local Populations, Bioanthropological Research and the Promotion of Public Health in Amazonia. H.P. SILVA.
  - 6 Primatologists' engagement with communities in Madagascar. S.R. TECOT.
  - 7 Partners in research? The complex challenge of engaging Toba/Qom people in human biology studies. C.R. VALEGGIA.

**Session 50: Triumphs and Tribulations in Teaching**

*Invited Poster Symposium.* Chair: Laurie Kauffman.

Co-organizer: Jessica Westin

**Archview Ballroom.**

A recent survey of the AAPA membership indicates a substantial number of contingent and teaching-focused faculty. Approximately 14% of AAPA members reported their "current primary position" as either "Temporary Position" or "Permanent Position, Teaching Faculty". According to the American Association of University Professors, more than 50% of faculty hold part-time positions, and more than 76% hold non-tenure track positions. The Higher Education Research Institute has found that 59.1% of faculty spend more than 9 hours per week preparing for teaching undergraduate courses, while a study of Boise State University faculty found professors spent 40% of their working time on teaching-related activities. These data demonstrate the importance of teaching and non-tenure track faculty in today's higher education landscape. The idea for this symposium grew out of the inaugural meeting of the Anthropologists outside of Anthropology departments, Contingent, and Teaching-focused faculty (AACT) Task Force, under the umbrella of the Committee on Diversity, which occurred at the 2014 meetings in Calgary. In this symposium, we provide a space for physical anthropologists to share a particular, broadly-defined teaching challenge or success. Additionally, we want to increase opportunities at the annual meetings for physical anthropologists to engage with others regarding their teaching, to share best-practices and solutions to teaching-related problems, and to gain teaching tools to help better serve students in whatever discipline we may teach. Symposium topics include the use of technology in the classroom, active and hands-on learning techniques, teaching through field courses, and overall measures of student success.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.  
9:15-10:00 Authors present  
10:15-10:45 discussion

- 10:15 Discussion: Marilyn London.
- 1 Correlates of success in science classes. J.L. WESTIN.
  - 2 Examination of Primate Conservation Knowledge amongst College Students. J.M. MORRIS, A. SKRINYER, L. LEASE.
  - 3 Engaging students through active participation in a community-based conservation initiative. C.T. CLOUTIER, A.R. HALLORAN.
  - 4 Experiential learning via research projects in freshmen biological anthropology courses. T.D. PAN, P.A. KRAMER.
  - 5 Field Courses for Non-Majors. L. KAUFFMAN.
  - 6 Body and Brain: Anatomy of team-based learning in a preclinical science course. A.B. TAYLOR, J. VELKEY, J. GWYER, L.E. WHITE.
  - 7 Evolve: Gameplay in Introductory Biological Anthropology Courses. M.C. PITRE, N.M. BURT, H.J. HUNOLD.
  - 8 Making physical anthropology "physical" in the online classroom: Digital collections and virtual experiences. J.D. CRAMER.
  - 9 Teaching with ePortfolios. M.S. SCHAEFER, K.J. LEWIS.
  - 10 ARE YOU READY TO RUMBLE?! Sports Championship Mimicry to Educate about Adaptations, Community Ecology, and Conservation. C.N. ANDERSON, K.L. LEWTON, J.A. DREW, K. HINDE.
  - 11 Twerking, Limericks, and 3D Printing: Shaking up Human Osteology Assignments. K. KILLGROVE, A.N. ACOSTA.
  - 12 Virtually there: Using live-feeding cameras to teach primate behavior. C.A. COOKE, M. RODRIGUES.
  - 13 Resurrecting lives: a contextualized data analysis and collaboration exercise in a bioarchaeology seminar. C. LIU.
  - 14 GenBank and the promise of online resources for undergraduate research. A. KITCHEN, J. STEINMETZ.
  - 15 Integrating Anthropology and Biology: Comparing success rates and learning outcomes across majors when taking Human Evolution. D.A. HERNANDEZ, K.D. O'NEILL, B.C. VERRELLI, A.L. RECTOR.

**Session 51: Broader Impacts: Effective Education and Public Outreach in Physical Anthropology**

*Invited Poster Symposium.* Chair: Caitlin M. Schrein. **Archview Ballroom.**



## Saturday Morning Sessions

Two initiatives stand out as motivating factors for effective education and public outreach in physical anthropology: the first is a global STEM education reform movement which seeks to populate the STEM workforce with highly trained, skilled workers, increase the number of qualified STEM educators at the K-12 level, and contribute to a science literate society; the second is an effort by granting agencies to expand the impacts of funded research projects to classrooms and the public by requiring researchers to include an education or outreach component in grant proposals. This symposium will address these initiatives by demonstrating (1) effective methods for and positive outcomes of teaching and learning about physical anthropology at the K-20 level, (2) the impact of public outreach via informal science programming, web-based resources and social media and (3) models of successful engagement programs for field researchers interested in working with local communities.

7:30 – 8:00 a.m. Poster set-up. 11:45-12:00 a.m. Poster take-down.

10:45-11:30 Authors present (Caitlin)

11:30 – 12:00 Discussion

11:30 Discussion: Holly Dunsworth, University of Rhode Island and Caitlin Schrein.

- 1 Physical anthropology education and undergraduate students' socioscientific decision-making and interest in science. C.M. SCHREIN.
- 2 Physical anthropology and evolution education research: Exploring physical anthropology students' evolutionary reasoning. E.P. BEGGROW.
- 3 Enhancing physical anthropology graduate education with public outreach in the K-12 classroom. C.M. MCCABE, E.R. CASTILLO, E. OTÁROLA-CASTILLO.
- 4 Education and outreach components of the Rising Star Expedition and Rising Star Workshop. J. HAWKS.
- 5 eAnthro: Community engagement in developing online learning resources. J. KAPPELMAN, A.P. WITZEL, R. GARZA, F. MCGRATH, R. MILLER, C. PITTMAN, D. REED, S. ROBERTSON, T. TANG, J. TENBARGE.
- 6 The Smithsonian's Human Origins Program: Broadening and deepening public engagement with human evolution through social media. B. POBINER.
- 7 6 Million Years in 6 Minutes: Teaching Human Evolution in an Informal Museum Learning Environment. J.M. ZICHELLO.
- 8 The Wenner-Gren Foundation and engaged anthropology. L.C. AIELLO.
- 9 Engaged Anthropology: Engaging Local Stakeholders and Decision Makers in Science and Conservation. J.D. PRUETZ.
- 10 The role of human evolution in science education: Impacts on students and the public. E. MEIKLE.
- 11 The educational importance of comedy in biological anthropology, one humerus pun at a time. N.A. REAGAN.

## Saturday, All day sessions.

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### Session 52: Primatology: Ecology and Conservation

*Contributed Poster Presentations.* Chair: Elizabeth G. Atkinson.

**Gateway Ballroom 2/3/4/5.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 5:00-5:45

- 1 The Application of 3D Digital Microscopy in Identifying Evidence of Human Butchery of Extant Lemurs. S.A. MATHENA, A.C. ZIMMER, L.R. GODFREY, V.R. PÉREZ.
- 2 Estimates of sympatric thick-tailed galago (*Otolemur crassicaudatus*) and southern lesser galago (*Galago moholi*) population densities in an Afromontane forest. K. FISH, M. WEAVER, B. GRUNDY.
- 3 Resource Use By Aye-Ayes in Small Forest Fragments in Eastern Madagascar. C. CARBONE, R. MILLER, M. IRWIN.
- 4 Together in solitude: Sifakas and bamboo lemurs cycle through food patches rapidly and rarely share. M.T. IRWIN, T. ANDRIAMISEDRA, L. BETTINO, M.C. FITZPATRICK, T. RANDRIAMASY, N. RABETOANDRO, H. VOLOLONORO, F. RAHARISON.
- 5 Home range shifts and demographic changes in two sympatric lemur species (*Indri indri* and *Propithecus diadema*) in Betampona Nature Reserve, Madagascar. L.M. KERKER, E.M. MERTZ.
- 6 Demography of the endangered Milne-Edward's sifaka (*Propithecus edwardsi*) in an unprotected degraded forest. A.J. ZAMORA, C. RASOLONDRVAOVY, P.C. WRIGHT.
- 7 Environmental instability and functional traits explain lemur ecological community structure. J.P. HERRERA.
- 8 GIS analysis of habitat usage by sympatric southern lesser (*Galago moholi*) and thick-tailed galagos (*Otolemur crassicaudatus*) in an Afromontane environment. E. LUTTRELL, K. FISH, M.L. SAUTHER, F.P. CUOZZO, M. WEAVER, L. GAUGLER.
- 9 Habitat quality and behavioral ecology of the Northern sportive lemur (*Lepilemur septentrionalis*). M.P. DINSMORE, E.E. LOUIS, JR., K.B. STRIER.



## Saturday All Day Sessions

- 10 Hair cortisol, climatic events, and age in wild ring-tailed lemur (*Lemur catta*) troops from the Beza Mahafaly Special Reserve, Southwestern Madagascar. S.A. FARDI, R.M. BERNSTEIN, M.L. SAUTHER.
- 11 Ring-tailed lemurs (*Lemur catta*) in small forest fragments: Which variables are the best predictors of population viability and juvenile recruitment? L. GOULD, L. COWEN, J.S. WEIR.
- 12 Frequent leaping origins: unpredictable substrate orientation and position as the selective context for euprimate visual system improvements. D.M. SCHRUTH.
- 13 Sex-linked stable isotope patterns in a Kenyan population of olive baboons (*Papio anubis*). R.S. NOCKERTS, M.L. WILSON, D.L. FOX, M. TAPPEN.
- 14 Y-Chromosomal Biogeography of *Cercopithecus mitis* in the Lomami Basin, Democratic Republic of the Congo. A.N. LEROY, A.J. TOSI, J.A. HART, K.M. DETWILER.
- 15 The history and current census of *Chlorocebus sabaues* in Dania Beach, Florida. D.M. WILLIAMS, K.M. DETWILER.
- 16 Exomic copy number variation in the macaques. T.H. WEBSTER, B.J. BRADLEY.
- 17 You are what you eat: Further analysis of the diet and feeding ecology of Barbary macaques (*Macaca sylvanus*) in Gibraltar. A.C. KWIATT, A. FUENTES, M.R. SCHURR, E. SHAW, J. CORTES, L. JONES-ENGEL, M. PIZARRO.
- 18 Spatial structure in the distribution of feeding trees used by the Japanese macaques of Yakushima Island, Japan. D.S. SPRAGUE, M. NISHIKAWA.
- 19 Genome-wide DNA methylation variation in baboon bone and cartilage. G.A. HOUSMAN, L.M. HAVILL, A.C. STONE.
- 20 Loud call variation in *Cercopithecus mona*: A proxy for genetic relatedness? K. WERLING, M. RAMSIER, R. MATSUDA GOODWIN, M. PATIÑO, K.J. BENSEN, M.E. GLENN.
- 21 Immunogenetic regulatory variation associated with parasite infection in the Ugandan red colobus. N.D. SIMONS, M.J. RUIZ-LOPEZ, C.A. CHAPMAN, T.L. GOLDBERG, K.N. STERNER, N. TING.
- 22 Preliminary report on the use of GPS/GSM tracking devices to estimate the vervet monkey (*Chlorocebus aethiops sabaues*) population on the island of St. Kitts. K.M. DORE.
- 23 Mitochondrial D-LOOP variation and structure of two island populations of urban macaques (*Macaca fascicularis*). A.R. KLEGARTH, M.D. GUMERT, C.M. RILEY, J. SRIKANTAN, R. MEIER, L. JONES-ENGEL, A. FUENTES, H. HOLLOCHER.
- 24 Clade-specific SNPs reveal hybrid ancestry of individuals in captive guenon populations. A.J. TOSI, K.M. DETWILER.
- 25 Macaques and the Ritual Production of Sacredness Among Balinese Transmigrants in South Sulawesi, Indonesia. J.V. PETERSON, N.P. OKA, E.P. RILEY.
- 26 The genetics of brain cortical folding in the baboon. E.G. ATKINSON, J. ROGERS, M.C. MAHANEY, L.A. COX, J.M. CHEVERUD.
- 27 The Gut Microbiome of Howler Monkeys (*Alouatta palliata*) in Costa Rica. L.R. WILLIAMS, F.P. CORCIONE, E. MARINI, A. LUONG, M. DOMINGUEZ-BELLO.
- 28 Tropical lianas: Correlations with habitat type and primate use at Brownsberg Nature Park, Suriname. J.W. MOORE, M.A. NORCONK, B.W. WRIGHT, J.A. LEDOGAR.
- 29 Investigating the presence of mycobacterial pathogens in New World primates. T.P. HONAP, G. HOUSMAN, G. ERKENSWICK, J. MALUKIEWICZ, V. BOERE, L. MACHADO PEREIRA, A.D. GRATIVOL, C.R. RUIZ-MIRANDA, I. DE OLIVEIRA E SILVA, M. WATSA, A.C. STONE.
- 30 Determinants of the gut microbiota of Mesoamerican howler monkeys (*Alouatta pigra* and *A. palliata*). K.R. AMATO, M. RAGUET-SCHOFIELD, N. RIGHINI, R. MARTINEZ-MOTA, R. KNIGHT, R.M. STUMPF, K.E. NELSON, B.A. WHITE, S.R. LEIGH.
- 31 Gibbon density in western Thailand: The influence of altitude and forest type. T.Q. BARTLETT, N. TANTIPISANUH, T. DAWRUENG, A. KAMJING, T. SAVINI.
- 32 Flowers or figs: Dietary choices in wild white-handed gibbons (*Hylobates lar*) in western Thailand. L.E. LIGHT.
- 33 Examining the co-evolution of primates and angiosperms: Brazein sweet proteins and gorilla taste receptors. E.E. GUEVARA, K. SALTONSTALL, A. CACCONI, N.I. MUNDY, B.J. BRADLEY.
- 34 Primate research and challenges to meaningful engagement in Côte d'Ivoire's Tai National Park. K. OUATTARA, E.E. KANE, W. MCGRAW.
- 35 The ecology of fear and savanna resource limitation in western chimpanzees (*Pan troglodytes verus*) at Fongoli, Senegal. S.M. LINDSHIELD, B.J. DANIELSON, J.D. PRUETZ.
- 36 Utilizing community interviews to develop a comprehensive species list at the Tonkolili Chimpanzee Project in Sierra Leone. B.A. NOBLE, A.R. HALLORAN, T.T. CLOUTIER, P. BAI SESAY.
- 37 Chimpanzees (*P.t. verus*) change the landscape of a forest fragment by dispersing cultivars raided from local villages. A.R. HALLORAN, C.T. CLOUTIER, C.E. BOLTEN, S.S. MONDE, P. BAI SESAY.
- 38 Reconstructing the mobility of Madagascar's fauna using strontium isotopes: results and implications for management and conservation. B.E. CROWLEY, P.A. SLATER, K.M. MULDOON, L.R. GODFREY.
- 39 Evolution of gene expression network underlying a disease state in humans and non-human primates. C.C. BABBITT, G.A. WRAY.
- 40 Drawing the Line: An Exploration into the Complex and Contradictory Relationships between Humans and Other Primates. A.D. CORTEZ.

## Saturday All Day Sessions

- 41 An efficient novel technique for genotyping MHC-DRB exon 2 in primates. C.M. BERGEY.
- 42 The impact of past climate cycles on the paleodemography of East African ungulates as inferred from genomic RAD-Seq data. S. HAUSEISEN, C. BERGEY, T. DISOTELL, A. BURRELL.
- 43 A comprehensive phylogenetic study of cranial morphology in Southeast Asian mammals. L. YAO, H. LI, R.S. MALHI, R.D. MARTIN.

**Session 53: Forensic anthropology and taphonomy**

*Contributed Poster Presentations.* Chair: Frank Rühli. **Gateway Ballroom 2/3/4/5.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 5:00-5:45

- 1 3D Geometric Morphometric Analysis of the Tibial Plateau for Sex Determination. K. MCGUIRE.
- 2 Skeletal age estimation for adults: Long-standing problems, recent developments, and a solution. S.M. GETZ, G.R. MILNER, J.L. BOLDSSEN.
- 3 Evaluation of mastoid process as a sex indicator using geometric morphometrics. H. JUNG, E. WOO, S. PAK.
- 4 Sex Estimation from Juvenile Human Crania: A Validation of Gonzalez (2012). M.K. SCHAYE.
- 5 The human glenoid morphology – a comparative cadaver based study. M. BURKHARD, S. MATHEWS, K. LINK, I. FRANKE, G. HARPER, F. QUERESHI, H. BLOCH, O. ULLRICH, E. EPPLER, F. RÜHLI.
- 6 Age Estimation from Osteoarthritis of the Shoulder in Modern North Americans. A.L. BRENNAMAN, K. LOVE-MYERS, J.D. BETHARD, J.T. POKINES.
- 7 Analysis of human rib fracture mode. D.L. MESSER, V.M. DOMINGUEZ, A.M. AGNEW.
- 8 Sex determination from the human sacrum: A re-assessment. A. FERNANDEZ, D.R. HUNT.
- 9 Variation in Osseous Histological Features in a Sample of Early Twentieth Century Americans. R.A. WALKER, K. MENNITTO.
- 10 A revised method for estimating age-at-death from palatal sutures using Bayesian statistics. S.M. HENS, K. GODDE.
- 11 Body Height of Mummified Pharaohs Supports Historical Suggestions of Sibling Marriages. M. HABICHT, M. HENNEBERG, L. OEHRSTROEM, K. STAUB, F. RÜHLI.
- 12 Correlations among morphoscopic traits in peoples of the Pacific. M.D. RATLIFF.
- 13 Sexual dimorphism of the femur in an Austrian population from the 19<sup>th</sup> and 20<sup>th</sup> century. F. KANZ, C. FITZL, F. FROMMLET.
- 14 Stature estimation from modern Southeast Asian skeletal remains: Placing the data in context. J.R. GOLIATH, M.C. STEWART, P. TUAMSUK.
- 15 Coding and Quantifying Traits on the Skull Used in Ancestry Estimations in Forensic Anthropology: Results from a Midwestern Amerindian Cemetery. A.M. DURCHHOLZ, S.D. SPENCER.
- 16 Success Rates of Sex Estimation by Forensic Anthropologists using Real-life Forensic Casework Data. R.M. THOMAS, C. PARKS, A. RICHARD.
- 17 Determination of ancestry from the skeleton: The application of nine existing methods produces inconsistent results. I.M. SIERP, M. HENNEBERG.
- 18 A digital framework for managing research data in skeletal collections. F. ENGEL, S. SCHLAGER.
- 19 The establishment of the Chinese Human Skeleton database based on the FileMaker. N. LIANG, Q. ZHANG, Z. SUN, L. GUO, Q. ZHANG, H. ZHU.
- 20 Extra-large upper molar cusp 5 or double metacone? A. CUCINA.
- 21 The consequence of the global supermarket on the isotope signatures of modern humans. M.M. WARNER, N.P. HERRMANN, Z. LI, W.R. TRASK, L.A. REGAN, R.L. JANTZ.
- 22 Preparing calcined bone for strontium isotope analyses: A modification to standard methods. D. GRAHAM, D. HONN.
- 23 Undocumented border crosser deaths in Florida: Preliminary results. A.N. FRIEND.
- 24 Comparing avian and terrestrial scavenging evidence and addressing why the Crested Caracara (*Caracara cheriway*) steals bones. L.R. PHARR, M. LEITNER, M.H. MANHEIN.
- 25 The Boars of Summer: Estimating Time-Since-Burial in Southwest Florida. M.D. ROLLAND, S.B. BOYS, H. WALSH-HANEY.
- 26 African American Cemeteries: The Tragedy of Overlooking the Marginalized. S.A. WADE, H. WALSH-HANEY.
- 27 Wet Grave Deadspace: Spatial Analysis of Cemeteries within New Orleans. S.A. BONCAL.
- 28 Experimentation of cut marks on bones: Reconstructing the force applied and type of weapon. C.L. HUMPHREY, M. HENNEBERG.
- 29 Experimental Assessment: Heavy Bladed Tool Mark Analysis in Relation to Dismemberment and Its Implications for Forensic Identification. M.L. HIGHSMITH, R.R. PAINE.
- 30 Fluvial Transport of Human Remains in the Three Rivers of Allegheny County, PA. S.M. KROPP.
- 31 Rethinking the Forensic Anthropology Classroom: Pedagogy in the 21<sup>st</sup> Century. S.B. BOYS, M.D. ROLLAND, H.A. WALSH-HANEY, L. FROST.
- 32 Undergraduate Myth Busters: Records vs Reality of Osteological Materials. L.D. GOODMAN, V. MOLOUGHNEY, M.

FARALDO, L. TAYLOR.

**Session 54: Nutrition, Health and Disease**

*Contributed Poster Presentations.* Chair: Margaret Clegg. **Gateway Ballroom 2/3/4/5.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 5:00-5:45

- 1 A test of parasite-host specificity between two closely-related species of Neotropical primate, *Saguinus fuscicollis* and *S. imperator*. G.A. ERKENSWICK, M. WATSA, A.S. GOZALO, P.G. PARKER.
- 2 Cannabis vs helminth infection: Cannabis use as chemoprophylaxis against intestinal helminth infection among Aka forest-foragers of the Central African Republic. C.J. ROULETTE, E.H. HAGEN.
- 3 Water and Wellness: Irrigation, Water Resources, and Growth in the Ethiopian Highlands. S. BEYENE, M.S. WILLIS, B. LEGESSE, M. MAMO, T. REGASSA, T. TADESSA, Y. WOLDEHAWARIAT.
- 4 Proliferation Response to Ethanol: *Porphyromonas gingivalis*. N.A. SHORT, P.W. EWALD.
- 5 The evidence of medicinal plant use in prehistoric humans from an archaeological site in Northeastern Brazil. I.T. SANTOS.
- 6 An evaluation of the relationship between Harris line and dental enamel hypoplasia development in an early Middle Ages skeletal sample from Northern France. E.C. BAIR, M.K. MOORE.
- 7 Dental Microwear Analyses and Dietary Reconstruction at Haminmangha, a Neolithic Site in Inner Mongolia, China. M. LI, Q. ZHANG, Z. SUN, Q. ZHANG, H. ZHU.
- 8 Inflammation and anthropometric indices during the pubertal transition: What do the commonly used markers mean? H. SHATTUCK-HEIDORN, M.W. REICHES, A.M. PRENTICE, S.E. MOORE, P.T. ELLISON.
- 9 Two evolutionary models of suicide stand up against the ethnographic record. K.L. SYME, Z. GARFIELD, E.H. HAGEN.
- 10 Reading the sources: How the historical record can help interpret results. M. CLEGG.
- 11 A case of severe hydrocephalus in a juvenile from the X-Group period of Sudanese Nubia (350-550 C.E.). K.N. HOPE, K.A. SIRAK, D.P. VAN GERVEN.
- 12 Diet and Health in the North Carolina Piedmont. K.L. REINBERGER, D.L. HUTCHINSON.
- 13 Diet and mobility of an Iron Age population in Switzerland – Stable carbon, nitrogen and sulphur isotope analysis of the human remains from Münsingen. N. MOGHADDAM, F. MÜLLER, A. HAFNER, S. LÖSCH.
- 14 Carbon and oxygen isotope ratios discriminate coastal and inland tropical foragers. M.M. VAKIENER, K.M. ENDICOTT, P. ENDICOTT, N.J. DOMINY.

**Session 55: Skeletal Biology: Growth and Development**

*Contributed Poster Presentations.* Chair: Marta P. Alfonso-Durruty.

**Gateway Ballroom 2/3/4/5.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 5:00-5:45

- 1 Skeletal growth impairment and subsequent recovery with the introduction of agriculture in Central Europe. A.A. MACINTOSH, R. PINHASI, J.T. STOCK.
- 2 Self-similarity is the appropriate null model for GMM studies of integration. F.L. BOOKSTEIN.
- 3 Non-specific indicators of stress and risk of mortality in industrializing London. G.M. HUGHES-MOREY.
- 4 Impacts of the number and types of teeth employed in assessing developmental ages from skeletal samples. D.E. BECKER, N.A. CASTELLON-HINKLE, L.E. CIRILLO, E.M. BURKE, J. DING, R.S. JABBOUR, G.D. RICHARDS.
- 5 Early-life growth deficits and adulthood mortality: developmental stress effects in KhoeSan foragers from southern Africa's Later Stone Age. L. DOYLE.
- 6 Correlation of long bone growth and dental development in Medieval Austria. J. VELISSARIS, R. RISY, D.U. RISSER, F. KANZ.
- 7 A comparative analysis of vertebral microstructure in Neanderthal and modern human infant spines. K.A. ROBSON BROWN, F. ACQUAAH, R.L. ABEL.
- 8 The effects of environmental conditions on the development of sexual dimorphism: a comparison of boys and girls from three Industrial European skeletal samples. S. REEDY.
- 9 A (w)hole new idea: Using nutrient foramen location to identify relative growth and the center of ossification in juvenile tibiae. E.R. DOVE, C.L. BURRELL, J.C. OHMAN, J.D. IRISH.
- 10 A Radiographic Approach to Age Estimation of the Subadult Knee Joint: A New Standard. M.E. BOEYER, S.D. OUSLEY.
- 11 Teeth versus bones: A review of biological age from dental development and long bone diaphyseal growth in subadult human remains. C.L. BURRELL, E.R. DOVE, M.M. EMERY, J.C. OHMAN.
- 12 Human nasal floor shape variation and its relationship to the anterior dentition. C.L. NICHOLAS, R.G. FRANCISCUS, B. POLICENI.
- 13 Plasticity of Human Lumbar Vertebrae as a Tool for Interpreting Age, Sex, and Life History. A.K. SMITH, L.J. REITSEMA.
- 14 Age-Related Trends in Human Trabecular Bone Connectivity at the Cortical-Trabecular Interface in the Proximal Tibia

## Saturday All Day Sessions

- Metaphysis. Z.R. HUBBELL, J.H. GOSMAN, T.M. RYAN.
- 15 Developmental plasticity in the tibia, but not femur, discriminates between European and US born males of European decent. E.E. HAMMERL, D.L. OSBORNE.
  - 16 Age changes in humeral asymmetry in Early Medieval period. K. FARKAŠOVÁ, V. SLÁDEK, M. HORA.
  - 17 Subadult mandibular morphology in an early medieval skeletal collection from Northern France compared with modern individuals of European ancestry. M.K. MOORE, E. HAMMERL.
  - 18 Investigation of craniofacial morphological variation at Sully (39SL4) utilizing patterns of postmarital residence. E.R. AGOSTO, A.H. MCKEOWN.
  - 19 Bone collagen stable isotope analysis of three late Holocene humans from Interior Alaska. C.M. HALFFMAN, R. SATTLER, J.L. CLARK.
  - 20 Stable isotope analysis of incremental sections of human dentin from Malawi (20<sup>th</sup> and 21<sup>st</sup> ct. AD). A.N. KARABOWICZ, R.L. QUINN, T.G. BROMAGE.
  - 21 A semi-automatic method for intracortical porosity quantification with application to intraskeletal variability. M.E. COLE, S.D. STOUT.
  - 22 A strontium isotope perspective on catchment area and intra-site subsistence variation. H. DE JONG, V. HEYD, C. HAWKESWORTH, A. PIKE, H. MELLER.
  - 23 The “Shear Resistance-Priority Hypothesis”: A Means for Enhancing Understanding of Material Adaptations in Bones that Habitually Experience Complex Loading. J.G. SKEDROS, K.E. KEENAN, C.S. MEARS, T.D. LANGSTON.
  - 24 Body Height and Body Mass Estimations for Prehistoric Maritime and Terrestrial Hunter-Gatherers of Patagonia and Tierra del Fuego, Chile. M.P. ALFONSO-DURRUTY, F. MORELLO.
  - 25 Pott’s in Bones Rather than Bones in Pots: Identification of Pott’s Disease (Tuberculosis) Through a Cooperative Approach. A.L. POLONITZA, H. WALSH-HANEY, M. COBURN, M. GOOLEY.

**Session 56: Paleoanthropology: Taphonomy, Taxonomy and Methods**

*Contributed Poster Presentations.* Chair: Clayton D. Pilbro.

**Gateway Ballroom 2/3/4/5.**

7:30 - 8:00 Poster set-up. 5:30 - 6:00 Poster take-down. Even numbered poster authors present for discussion 10:00-10:30 and 4:45-5:30 - Odd numbered poster authors present for discussion 10:30-11:00 and 5:00-5:45

- 1 Cannibalism vs funerary defleshing and disarticulation after a period of decay: a comparison of modifications on human remains from four prehistoric sites. S.M. BELLO, R. WALLDUCK.
- 2 Cannibalism vs funerary defleshing and disarticulation after a period of decay: micro-morphometric comparisons of cut-marks on human and non-human remains from four prehistoric sites. R.J. WALLDUCK, S.M. BELLO.
- 3 Taphonomy of Hominin-bearing Middle Pliocene Localities at Woranso-Mille, Ethiopia. S.C. CURRAN, Y. HAILE-SELASSIE.
- 4 Quantitative Analysis of Variation in Molar Crown ‘Flare’ in Modern Humans and Chacma Baboons. D. DE VRIES, S.N. CICCIO, F.E. GRINE.
- 5 Comparing morphometric methods in *Macaca mulatta* crania. R.R. GLENZER, K.S. CLARKE, M. ANDERSON, A.R. ELLER, F.J. WHITE, S.R. FROST.
- 6 A method for analyzing complex joint surfaces in ecomorphology using slope rasters derived from Digital Elevation Models. W. BARR, R.H. DUNN.
- 7 Micro high-resolution x-ray computed tomography of fossil Plesiadapiform (stem-primate) teeth to remove inter and intra specific measurement errors. C.D. PILBRO.
- 8 Geometric morphometric analysis and internal structure measurements of Neanderthal and modern human lower second premolars. C.C. BAUER, S. BENAZZI, K. HARVATI.
- 9 Burial laws and protocols: Elucidating processes and optimizing strategies via the Taphonomic Information System (TAPHONOMIS). A.J. ALVESHERE.
- 10 Can the sex of hominin pelvic fossils be assessed using methods developed for recent humans? C. VANSICKLE.
- 11 The evolution of the human niche: assessing and describing the development of complex decision-making in the Pleistocene through an open-access, comparative database. M. KISSEL, A. FUENTES, C. DEANE-DRUMMOND.
- 12 The Case for Uncertainty: Quantifying Isotopic Uncertainty with Bayesian Mixing Models. M.I. HAMILTON.
- 13 The Use of Ecological Niche Modeling Methods to Test Models of Neanderthal Extinction. R.C. BIBLE.

## Saturday, Afternoon sessions.

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### Session 57: Paleoanthropology: Hominins, taxonomy and taphonomy

*Contributed Podium Presentations.* Chair: Susanne Cote. **Ballpark 1/2.**

- 2:00 Estimating the relative abundance of Pliocene hominins in eastern Africa: implications for species distributions. A. VILLASEÑOR, R. BOBE.
- 2:15 Hip joint osteoarthritis in the MLD 46 (*Australopithecus africanus*) proximal femur. M. HAEUSLER, S. LANDIS, B. ZIPFEL.
- 2:30 Trabecular morphology at the talocalcaneal and calcaneocuboid joints in StW 352 (*Australopithecus africanus*). A. ZEININGER, K.J. CARLSON.
- 2:45 Evolvability and Autonomy of Limb Proportions in *Homo* and other Hominoids. J.D. POLK, S.A. WILLIAMS, M.W. GRABOWSKI, C.C. ROSEMAN.
- 3:00 Using Manual Phalangeal Curvature to Explore Locomotion in Extinct Hominoids. S.A. MATARAZZO.
- 3:15 Species recognition among Lower Pleistocene fossil hominins based on distal humeral diaphyseal shape. M.R. LAGUE.
- 3:30 Walking back the cat: Unsupervised classification as an aid in “remote” fossil prospecting. G.C. CONROY.
- 3:45 Mouse models for identifying hybridization in the hominin fossil record: preliminary results. K.A. WARREN, T. RITZMAN, C.J. PERCIVAL, B. HALLGRIMSSON, R.R. ACKERMANN.
- 4:00 Unexpected results from the ventral side of the hominoid scapula. D.J. GREEN, T.A. SPIEWAK, B.C. SEITELMAN, P. GUNZ.
- 4:15 Absence of evidence or evidence of absence? The role of sampling in fossil primate distribution patterns. S. COTE.
- 4:30 Gray matter in the left inferior parietal cortex is expanded in chimpanzees with greater skill at tool-use. L.D. REYES, C.C. SHERWOOD, W.D. HOPKINS.
- 4:45 Leporids, landscapes, and the paleoenvironment: Stable isotope ratios of rabbit and hare bones reflect local environmental conditions at modern and archaeological sites. A.D. SOMERVILLE, A.W. FROEHLE, M.J. SCHOENINGER.
- 5:00 Break and posters

### Session 58: Human Biology

*Contributed Podium Presentations.* Chair: Robin G Nelson. **Broadway.**

- 2:00 The Shuar Health and Life History Project: Childhood somatic resources, linear growth, and immune function among indigenous Amazonians. S.S. URLACHER, J.J. SNODGRASS, M.A. LIEBERT, T.J. CEPON-ROBINS, T.E. GILDNER, L.S. SUGIYAMA.
- 2:15 The Shuar Health and Life History Project: Testing the Hygiene Hypothesis—Soil-transmitted helminth infection and immune dysregulation among the Shuar of Amazonian Ecuador. T.J. CEPON-ROBINS, T.E. GILDNER, M.A. LIEBERT, S.S. URLACHER, F.C. MADIMENOS, J. SNODGRASS, L.S. SUGIYAMA.
- 2:30 Does early-life environment cause differences in costs of reproduction in a preindustrial human population? I. NENKO, A.D. HAYWARD, M.J. SIMONS, V. LUMMAA.
- 2:45 Testing competing ideas about the relationship between body shape and wellbeing using a global sample of infants and children. C.A. HADLEY, D.J. HRUSCHKA.
- 3:00 Prenatal exposure to sex hormones in relation to sex hormones in women of reproductive age. M. KLIMEK, A. GALBARCZYK, H. COLLERAN, I. THUNE, P.T. ELLISON, A. ZIOMKIEWICZ-WICHARY, G. JASIENSKA.
- 3:15 Access to electric light is associated with shorter sleep duration in Toba communities of the Argentinean Chaco. H.O. DE LA IGLESIA, E. FERNÁNDEZ-DUQUE, N. LANZA, D.A. GOLOMBEK, J.F. DUFFY, C.D. CZEISLER, C.R. VALEGGIA.
- 3:30 Mapping language networks in the human brain. I.D. GEORGE, D.Q. BEVERSDORF, K. ALDRIDGE.
- 3:45 Time, residential stability, and gender-specific growth changes in orphaned Jamaican children. R.G. NELSON.
- 4:00 Greater family size is associated with less sleep among Tsimané parents. G. YETISH, J. SIEGEL, M. GURVEN, H. KAPLAN.
- 4:15 Life Expectancy Changes in the German Immigrant Population in Franklin County, Indiana: A Multigenerational Comparison. M.L. REID, J.H. LANGDON.
- 4:30 An Enigma in the Wisdom: Puzzling through Predictors of Third Molar Agenesis. K.E. CARTER, S. WORTHINGTON.
- 5:00 Break and posters

### Session 59: Skeletal Biology: Demography and Forensic Anthropology

*Contributed Podium Presentations.* Chair: Gary P Aronsen. **Grand Ballroom A/B.**

- 2:00 Migration and the Greater Context: Where to now? A.C. CAINE, H.A. SHAW.
- 2:15 Can sexual dimorphism be expressed differently across human populations? A.G. KITTOE.
- 2:30 Foreigners in Fröjel?: A Study of Mobility on a Viking Age Port of Trade in Gotland, Sweden. E.M. PESCHEL, J. BETHARD, M.C. BEAUDRY.
- 2:45 The YNH4: Multidisciplinary review of skeletons from New Haven, CT’s first Roman Catholic Church cemetery reveal ancestry, economic, social and health indicators. G.P. ARONSEN, L. FEHREN-SCHMITZ, J. KRIGBAUM, G.D. KAMENOV, G.J.



## Saturday Afternoon Sessions

CONLOGUE, N.A. PELLATIER, T. GRGURICH, R.B. LOMBARDO, Y. TONOIKE, D.W. DE LUCA, A. GRIEGO, H.T. ECKELS, N.F. BELLANTONI.

- 3:00 Necropolitics and Bioarchaeology: Enduring Legacies and Ethical Responsibilities. H.A. SHAW, S.A. LACY, P.L. GELLER.  
 3:15 Apotropaics and the undead: A biogeochemical assessment of vampire burials in post-medieval Poland. L.A. GREGORICKA, T.K. BETSINGER, A.B. SCOTT, M. POLCYN.  
 3:30 Diagnosis by consensus: Interpreting mummified pathological conditions. A.D. WADE, R. BECKETT, G. CONLOGUE, G. GARVIN, S. SALEEM, G. NATALE, D. CARAMELLA, A. NELSON.  
 3:45 An Analysis of Sexual Dimorphism Using Geometric Morphometrics of the Femur and Tibia; The Use of GM in Assessing Sex of Fragmented Remains. A.K. COSTELLO.  
 4:00 Thermal changes in the people of Herculaneum. E.R. OAKLEY, R.C. BROWER, C.W. SCHMIDT, R. D'ANASTASIO, J. VICIANO.  
 4:15 Comparing the face to the body, which is better for identification? T.A. LUCAS, M. HENNEBERG.  
 4:30 BADaBooM – a New Database Solution for Bioarchaeology. J.E. KAISER.  
 5:00 Break and posters

**Session 60: Primatology: Life History**

*Contributed Podium Presentations.* Chair: Zarin Machanda. **Grand Ballroom E/F/G.**

- 2:00 Don't judge a female by her swelling: variability in the timing of ovulation in relation to sexual swelling patterns in wild female bonobos (*Pan paniscus*). P. DOUGLAS, G. HOHMANN, T. DESCHNER.  
 2:15 Age belies reproductive status in a wild population of *Saguinus fuscicollis* and *S. imperator* in southeastern Peru. M. WATSA, G.A. ERKENSWICK, D.T. RASMUSSEN.  
 2:30 Infanticide pressure and group size affect natal coat development in wild *Colobus vellerosus* at Boabeng-Fiema Monkey Sanctuary, Ghana. I. BĂDESCU, E.C. WIKBERG, L.J. MACDONALD, S.A. FOX, J.V. VAYRO, P. SICOTTE.  
 2:45 The ontogeny of foraging behavior in wild chimpanzees (*Pan troglodytes schweinfurthii*). J. BRAY, Z.P. MACHANDA, M.N. MULLER, R.W. WRANGHAM.  
 3:00 Chimpanzee brain size growth: Comparing captive mass and wild volume data. Z. COFRAN.  
 3:15 Musculoskeletal growth patterns in wild chimpanzees (*Pan troglodytes*). Z. MACHANDA, N.F. BRAZEAU, E. CASTILLO, E. OTÁROLA-CASTILLO, H. PONTZER, M. EMERY THOMPSON, M. MULLER, R.W. WRANGHAM.  
 3:30 Juvenile growth and socioecological correlates in a wild colobine. K. OSSI-LUPO, A. KOENIG.  
 3:45 What facilitates facultative allomaternal care in red-bellied lemurs (*Eulemur rubriventer*)? A preliminary investigation. A.L. BADEN, S.R. TECOT.  
 4:00 Adrenal development and androgen-immune interactions in orangutans (*Pongo pygmaeus morio*). S.P. PRALL, M.P. MUEHLENBEIN.  
 4:15 Differences in life history strategies in bonobos and chimpanzees: evidence from age-related changes in urinary testosterone levels. V. BEHRINGER, T. DESCHNER, C. DEIMEL, J.M. STEVENS, G. HOHMANN.  
 4:30 A COMPARATIVE STUDY OF THE EXTERNAL GENITALIA OF FEMALE HYLOBATIDS: ADOLESCENT *Nomascus* MASQUERADE AS MALES. J.F. DAHL.  
 4:45 Boldness in wild vervet monkeys: individual differences and consistency across contexts. M.B. BLASZCZYK.  
 5:00 Break and posters



Poster presentations indicated as Session#.Poster # (i.e., "13.14 is Poster # 14 in Session 13). Podium presentations indicated as Session #[presentation time] (i.e., '32[4:45] is a paper starting at 4:45 pm in Session 32). Chairs and discussants indicated by Session #[Chair] or Session #[Discussant].

**A**

Abavandimwe, Didier, 12.6  
 Abel, Haley, 13.23  
 Abel, Richard L, 55.7  
 Abel, Suzanne, 9.33  
 Abella, Elicia, 8.22  
 Abondano, Laura A, 33.34  
 Abshire, Sarah, 31.17  
 Ackermann, Rebecca R, 39[1:00], 57[3:45]  
 Acosta, Andrea N, 50.11  
 Acquah, Frank, 55.7  
 Adams, Donovan, 11.7  
 Adams, Justin W, 8.28, 30.27  
 Agarwal, Mahima, 18[3:30]  
 Agnew, Amanda M, 32.3, 32.6, 32.8, 32.16, 53.7  
 Agoada, David, 32.25  
 Agosto, Elizabeth R, 55.18  
 Aguado, William D, 33.23  
 Aiello, Leslie C, 49[Discussant], 51.8  
 Alajbegovic, Katarina, 38[3:15]  
 Alba, David M, 8.39  
 Aldrich, Melinda C, 44[8:30]  
 Aldridge, Kristina, 58[3:30]  
 Alemseged, Zeresenay, 12.15  
 Alex, Bridget A, 35.18  
 Alexander, John P, 25[8:15]  
 Alfarano, Alexandria S, 34.8  
 Alfonso-Durruty, Marta P, 55[Chair], 55.24  
 Algee-Hewitt, Bridget FB, 5[Chair], 5.1, 5.5, 28.15  
 Allam, Adel H, 20.6, 20.7  
 Allen, James P, 24[9:00]  
 Allen, Kari L, 8.14  
 Allen, William L, 4[11:30]  
 Allen-Blevins, Cary, 12.3  
 Alleyn, Jessica, 19.15  
 Allué, Ethel, 22[10:30]  
 Almasy, Laura, 27.10  
 Almskaar, Kristin D, 12.1  
 Almécija, Sergio, 8.37, 8.39, 16[2:45], 30.22  
 Alt, Kurt W, 5.10  
 Alva, Ana, 9.12  
 Alveshere, Andrea J, 56.9  
 Amanullah, Sarah, 17[2:00]  
 Amato, Katherine R, 52.30  
 Ambrose, Stanley H, 6.3  
 Anderson, Christopher N, 50.10  
 Anderson, Monya, 8.26, 31.31, 31.32, 56.5  
 Andrews, Peter, 22[10:30]  
 Andrews, Sylvia Hixson, 22[10:30]  
 Andriamisedra, Tsarafilamatra Rotsinomena, 52.4  
 Anemone, Robert L, 8.17  
 Anson, Timothy, 3[11:00]  
 Antoine, Daniel M, 20.5  
 Antón, Susan C, 22[Discussant], 30.15  
 Apetrei, Cristian, 26[10:15]  
 Apple, Erin D, 34.7  
 Appleton, Laurel M, 14.4  
 Aranburu, Arantza, 43[8:00]  
 Arandjelovic, Mimi, 2[9:15]  
 Arbenz-Smith, Keely, 11.26  
 Arceno, Mark Anthony, 37[3:15]  
 Areces, Cristina, 13.5  
 Arenson, Julia L, 31.32  
 Arias, Macarena, 13.12

Armstrong, George J, 3[8:15], 9.43  
 Armstrong, Loren L, 5.14, 44[11:30]  
 Arnaiz-Villena, Antonio, 13.5  
 Arneborg, Jette, 37[3:00]  
 Arney, Irisa D, 8.38  
 Aronsen, Gary P, 59[Chair, 2:45]  
 Arora, Manish, 38[1:15]  
 Arsuaga, Juan Luis, 19.8, 43[Chair, 8:00, 8:15, 8:30, 9:15, 9:30, 9:45, 10:15, 10:30, 10:45]  
 Arya, Rector, 27.10  
 Asryan, Lena, 22[10:30]  
 Astorino, Claudia M, 11.4  
 Atkinson, Elizabeth G, 52[Chair], 52.26  
 Auerbach, Benjamin M, 5.3, 19.10, 32.14, 34.31  
 Austin, Anne E, 28.12  
 Austin, Christine, 38[1:15]  
 Austin, Rita M, 32.2  
 Avila, Maria Luisa, 49.1  
 Azcorra, Hugo, 49.1  
 Azzam, Andrew, 18[1:45]

**B**

Baab, Karen L, 32.34, 39[3:30]  
 Babbitt, Courtney C, 1[9:15], 52.39  
 Babrowski, Kara, 13.18, 13.19  
 Bacon, Anne-Marie, 22[11:15]  
 Baden, Andrea L, 60[3:45]  
 Bader, Alyssa C, 5.15  
 Bădescu, Iulia, 60[2:30]  
 Badr, Ibrahim, 20.6  
 Bae, Christopher J, 22[Chair, 11:00, 11:30]  
 Bai Sesay, Papanie, 52.36, 52.37  
 Bailey, Jeannie F, 32.27  
 Bailey, Katie, 31.8  
 Bailey, Shara, 8.40, 11.4, 11.9, 22[11:00], 35.2  
 Bair, Emily C, 54.6  
 Baires, Sarah E, 6.5  
 Baker, Brenda J, 28.7  
 Balaram, Pooja, 8.16  
 Baldi, N Roberto F, 27.1, 27.2  
 Bales, Ashley D, 8.34  
 Ball, Kevin A, 31.1  
 Balolia, Katharine L, 8.31  
 Baltakhinova, Marina E, 27.18  
 Bamshad, Michael J, 44[9:30]  
 Baptista, Marlyse, 5.6  
 Barash, Alon, 16[1:45]  
 Barclay, Jenifer, 41.2  
 Bardi, Massimo, 33.22  
 Barger, Nicole, 33.8, 34.15  
 Barkai, Ran, 35.4  
 Barr, W. Andrew, 56.6  
 Barrantes, Ramiro, 27.1  
 Barreiro, Luis B, 2[10:45]  
 Barrett, Christopher E, 34.6  
 Barros, Anna P, 25[8:30]  
 Bartelink, Eric J, 14.15  
 Bartlett, Thad Q, 52.31  
 Barton, Nick, 35.5  
 Bastarrachea, Raul, 27.13  
 Batai, Ken, 13.18, 13.19  
 Bathina, Krishna, 30.28  
 Bauer, Catherine C, 56.8  
 Bauer, Kai, 48[10:45]  
 Bauer, Miroslav, 13.17  
 Bauerle, Megan C, 11.32, 11.37  
 Bauernfeind, Amy L, 1[9:15]  
 Bauerova, Maria, 13.17  
 Bauman, Margaret L, 33.5  
 Baumgarten, Sarah E, 9.16  
 Beard, K. Christopher, 36[2:15]  
 Beasley, Melanie M, 16[1:30]  
 Beaty, Kristie G, 27.2, 27.5  
 Beaudry, Mary C, 59[2:30]  
 Beck, Jess, 9.40  
 Becker, Dana E, 55.4  
 Beckett, Ronald, 59[3:30]  
 Beehner, Jacinta C, 26[8:00, 8:15, 8:30], 29.4  
 Been, Ella, 16[1:45], 32.27  
 Beggrow, Elizabeth P, 51.2  
 Begun, David R, 25[11:30], 31.2, 31.3  
 Beheim, Bret, 1[11:30], 37[2:30]  
 Behrens, Jess J, 44[11:30]  
 Behrensmeyer, Anna K, 39[1:30]  
 Behringer, Verena, 60[4:15]  
 Beisner, Brianne A, 45[8:00]  
 Bekvalac, Jelena J, 21.2  
 Bellantoni, Nicholas F, 59[2:45]  
 Bell, Eviana, 33.9  
 Bello, Silvia M, 56.1, 56.2  
 Benavidez, Kathryn M, 4[9:00]  
 Benazzi, Stefano, 30.7, 30.8, 35.2, 35.4, 56.8  
 Benefit, Brenda R, 8.33, 8.38, 33.3, 33.13  
 Benitez, Marcela E, 26[8:15]  
 Benitez, Robert A, 22[11:00, 11:30]  
 Benn Torres, Jada P, 13.14, 44[8:00]  
 Bensen, Keith J, 52.20  
 Berezina, Natalia, 3[11:15], 10.27  
 Berger, Lee R, 16[2:00], 30.7, 30.8, 30.14, 30.17  
 Bergey, Christina, 2[11:00], 52.41, 52.42  
 Bergman, Thore J, 26[8:00, 8:15, 8:30, 8:45], 29.4  
 Bergstrom, Mackenzie L, 4[8:45, 11:00]  
 Bermúdez de Castro, José María, 43[9:00]  
 Bernard, Andrew, 4[11:15]  
 Bernardi, Margot, 8.3  
 Berner, Margit, 19.12, 19.14  
 Bernstein, Robin M, 52.10  
 Berthaume, Michael A, 16[3:45], 30.7, 30.8  
 Bertrand, Benoît, 11.28  
 Bertranpetit, Jaume, 18[3:15]  
 Best, Lyle G, 27.12  
 Bethard, Jonathan D, 11.34, 41[Chair], 41.9, 53.6, 59[2:30]  
 Betsinger, Tracy K, 59[3:15]  
 Bettino, Lauren, 52.4  
 Beverly, Emily J, 39[2:30]  
 Beversdorf, David Q, 58[3:30]  
 Beyene, Shimelis, 54.3  
 Beyens, Anne M, 10.1  
 Bhat, Uttam, 24[9:45]  
 Bible, Rachael C, 56.13  
 Bigham, Abigail W, 44[Chair]  
 Binder, Michaela, 20[Chair], 20.2, 20.4  
 Bishop, Laura C, 39[2:30]  
 Bistrekova, Vanya, 31.17  
 Bitadze, Lia, 18[1:45]  
 Bjarnason, Alexander, 8.11

- Black, Shannon R, 11.35  
 Blackwell, Aaron D, 34.1, 37[2:00], 47[9:30]  
 Blanco, Marina B, 42.9  
 Blangero, John, 27.10  
 Blankenship-Sefczek, Erin C, 11.35  
 Blaszczyk, Maryjka B, 60[4:45]  
 Blatt, Samantha H, 11.24  
 Bleuze, Michele M, 34.25  
 Bloch, Hans, 53.5  
 Bloch, Jonathan I, 8.4, 8.6, 8.8, 25[8:15]  
 Blom, Deborah E, 24[9:00]  
 Blumenthal, Scott A, 39[2:30]  
 Boaretto, Elisabetta, 35.18  
 Bobe, René, 34.17, 39[1:30], 57[2:00]  
 Boere, Vanner, 2[10:30], 52.29  
 Boesch, Christophe, 33.6  
 Boeyer, Melanie E, 55.10  
 Bogin, Barry, 49.1  
 Boldsen, Jepsen L, 53.2  
 Bolnick, Deborah A, 5.14, 13.6, 13.9, 44[10:45]  
 Bolten, Catherine E, 52.37  
 Bolter, Debra R, 31.24  
 Boncal, Sarah A, 53.27  
 Bonmatí, Alejandro, 43[9:30]  
 Bonnell, Tyler R, 25[9:15]  
 Bookstein, Fred L, 55.2  
 Boose, Klaree J, 26[9:45]  
 Borecki, Ingrid, 13.23, 27.17  
 Boren, Seth B, 31.7  
 Borgerson, Cortni, 45[10:45]  
 Borries, Carola, 4[10:45], 12.9, 33.27  
 Bos, Kirsten I, 2[11:15]  
 Botigue, Laura R, 18[1:00]  
 Boubli, Jean P, 2[8:30]  
 Boufana, Belgees, 30.30  
 Bouwman, Abigail S, 13.4, 37[3:00]  
 Bouzouggar, Jalil, 35.5  
 Bowden, Rachel L, 33.22  
 Boyer, Doug M, 8.4, 8.6, 8.8, 8.12, 8.29, 11.23, 25[8:00, 8:15], 31.21, 31.23  
 Boyle, Eve K, 30.5  
 Boys, Serrin B, 53.25, 53.31  
 Bradley, Brenda J, 2[8:45], 52.16, 52.33  
 Braga, Jose, 22[11:15]  
 Brand, Colin M, 33.10  
 Brandt, Guido, 5.10  
 Bransford, Timothy D, 1[10:45], 45[9:30]  
 Brassey, Charlotte A, 19.3  
 Braun, David R, 39[1:30]  
 Bray, Joel, 33.39, 60[2:45]  
 Brazeau, Nicholas F, 1[10:30], 60[3:15]  
 Brennaman, Ashley L, 53.6  
 Bretzke, Knut, 22[8:45]  
 Breuer, Thomas, 12.6  
 Bribiescas, Richard G, 34.9, 37[3:45]  
 Brinkworth, Jessica F, 2[Chair], 10:45]  
 Britz, Hayley, 31.28  
 Broadfield, Douglas C, 16[3:00], 46[11:15, 11:30]  
 Brockman, Diane K, 12.2  
 Bromage, Timothy G, 1[8:15], 11.26, 31.42, 55.20  
 Brooks, Alison, 22[Discussant]  
 Brooks, Keegan T, 14.8, 14.10  
 Brophy, Juliet K, 30[Chair], 30.14  
 Broughton, Margaret J, 42.7  
 Brower, Rebecca C, 59[4:00]  
 Brown, Elizabeth A, 18[3:00]  
 Brown, Frank, 39[2:15]  
 Brown, Kevin A, 45[8:15]  
 Brown, Mary H, 1[8:45]  
 Brown, Michelle, 7.3  
 Brown, Peter, 39[3:30]  
 Bruch, Angela, 22[8:15]  
 Bruwelheide, Kari S, 9.10  
 Bryant, Ashley, 8.17  
 Buck, Sharon M, 10.8  
 Buckberry, Jo, 24[9:30]  
 Buckley, Hallie R, 24[8:45]  
 Buikstra, Jane, 2[11:15], 24[11:45], 28[8:15], 28.14, 40[Discussant]  
 Bullion, Elissa A, 28.4  
 Burchell, Meghan, 48[11:45]  
 Burgess, M. Loring, 19.5  
 Burke, Elaine M, 55.4  
 Burkhard, Marco, 53.5  
 Burns, Kathryn, 22[11:30]  
 Burrell, Andrew, 2[11:00], 12.10, 52.42  
 Burrell, Carla L, 55.9, 55.11  
 Burrows, Anne M, 36[3:15, 3:45]  
 Burt, Nicole M, 24[8:30], 50.7  
 Bustamante, Carlos D, 18[1:00]  
 Butaric, Lauren N, 30.11, 32.35  
 Butcher, Michael T, 31.11  
 Butterfield, Timothy, 31.17  
 Buzhilova, Alexandra P, 3[11:15]  
 Buzon, Michele R, 9.41  
 Byrd, Rachael M, 14.1  
 Byrnes, Jennifer F, 41[Chair], 41.8  
 Byron, Craig, 30.7, 30.8
- C**  
 Cabana, Graciela, 5[9:00], 5.2, 5.3, 5.12, 9.13, 28.15, 40.4  
 Cabo, Luis L, 34.12  
 Caccone, Adalgisa, 52.33  
 Cáceres, Isabel, 22[10:30]  
 Caine, Alyson C, 59[2:00]  
 Calafell, Francesc, 18[3:15]  
 Calce, Stephanie E, 21.5  
 Calderwood, Laura, 24[9:30]  
 Caldwell, Sarah J, 9.41  
 Califf, Joseph, 33.21  
 Cameron, Ken, 2[9:15]  
 Cameron, Michelle E, 38[3:00]  
 Cameron, Noël, 19.6  
 Campanacho, Vanessa, 38[2:45]  
 Campbell, Christina J, 45[9:45]  
 Campbell, Meadow L, 31.37  
 Campbell, Roselyn A, 3[8:00]  
 Campbell, Ryan M, 11.18, 31.37  
 Campos, Fernando A, 4[11:00], 45[9:15]  
 Canales-Espinosa, Domingo, 26[8:45]  
 Canci, Alessandro, 37[3:00]  
 Cann, Howard, 18[1:00]  
 Cantor, Rita M, 2[9:45]  
 Capellini, Terence D, 18[3:00], 25[10:45]  
 Capitanio, John P, 1[10:15]  
 Cappellini, Enrico, 37[3:00]  
 Caprioli, Richard M, 1[9:15]  
 Caramella, Davide, 59[3:30]  
 Carbaugh, Aimee, 6.4, 6.6  
 Carbone, Claudia, 52.3  
 Cargill, Tyler M, 10.22  
 Carlson, Keely B, 30.8, 30.17  
 Carlson, Kristian J, 16[3:00], 30.3, 30.7, 30.8, 30.20, 39[1:45], 57[2:30]  
 Carnation, Stevie L, 25[10:30]  
 Carpenter, Morgan G, 27.2  
 Carr, Monica, 2[10:15]  
 Carretero, Jose Miguel, 19.8, 43[9:45, 10:30]  
 Carter, Katherine E, 58[4:30]  
 Carter, Yasmin, 32.4  
 Casado, Ana M, 9.4, 14.16  
 Castellon-Hinkle, Natasha A, 55.4  
 Castillo, Eric, 17[2:00, 3:30], 51.3, 60[3:15]  
 Castillo, Maria Teresa, 49.1  
 Catlett, Kierstin K, 11.5  
 Cawley, William D, 10.26  
 Cepon-Robins, Tara J, 58[2:00, 2:15]  
 Cerling, Thure E, 39[2:30]  
 Chadwell, Brad A, 25[9:30]  
 Chalk, Janine, 30.7, 30.8  
 Chamberlain, Andrew T, 32.13, 38[2:45]  
 Chan, Joyce, 10.13  
 Chapelle, Kimberley EJ, 16[3:00]  
 Chapman, Colin A, 4[9:00], 12.14, 25[9:15], 45[8:15], 52.21  
 Chatterji, Somnath, 34.32  
 Chavanaves, Sakdapong, 35.19  
 Chen, Jun, 22[11:00]  
 Cheney, Dorothy L, 26[8:00]  
 Cheronet, Olivia, 40.15  
 Chester, Stephen G. B, 8.8  
 Cheverko, Colleen M, 14.15  
 Cheverud, James M, 2[9:00], 52.26  
 Chevrier, Benoît, 22[8:00]  
 Chew, Amy E, 8.7  
 Child, Stephanie L, 10.25, 32.26  
 Chipman, Jonathan W, 45[11:00]  
 Chisholm, Brian S, 48[11:45]  
 Chitanava, David, 18[1:45]  
 Chittoor, Geetha, 27.12  
 Choe, Jae Chun, 42.11  
 Chowdhury, Shahrina, 29.2  
 Christensen, John N, 45[11:00]  
 Christensen, Rj, 37[3:00]  
 Chugani, Harry T, 1[9:00]  
 Chumbimuni-Torres, Karin, 9.15  
 Churchill, Steven E, 16[2:00], 19.6, 30.14  
 Ciccio, Stephanie N, 56.4  
 Cirillo, Laura E, 32.33, 55.4  
 Clancy, Kathryn B. H, 27.11, 34.2, 34.10, 47[Chair, 8:15]  
 Clark, Allison N, 11.16  
 Clark, Jamie L, 55.19  
 Clark, Melissa A, 9.4, 14.16  
 Clarke, Kelsey S, 31.31, 56.5  
 Clarke, Siobhan, 10.9  
 Clausing, Elizabeth, 5.9  
 Claxton, Alexander, 38[2:15]  
 Clegg, Margaret, 30.19, 54[Chair], 54.10  
 Clement, John, 32.4  
 Cloutier, Christina T, 50.3, 52.36, 52.37  
 Coad, Megann K, 11.32  
 Coburn, Marta, 55.25  
 Codron, Daryl, 33.18  
 Cofran, Zachary, 60[3:00]  
 Cohen, Jeffrey H, 37[3:15]  
 Cohen, Sarah, 38[1:00]  
 Coiner-Collier, Susan, 23[8:30]  
 Colard, Thomas, 11.28  
 Cole, Mary E, 55.21

- Cole, Shelley A, 27.12  
 Coleman, Drew S, 9.34  
 Collard, Mark, 17[1:15], 19.11, 30.16  
 Colleran, Heidi, 58[3:00]  
 Collins, Matthew J, 37[3:00]  
 Colman, Albert S, 30.29  
 Comas, David, 18[3:15]  
 Compton, Tim, 22[10:30]  
 Comuzzie, Anthony G, 27.10, 27.13  
 Conard, Nicholas J, 22[8:45]  
 Congdon, Kimberly A, 31.4  
 Conlogue, Gerald J, 59[2:45, 3:30]  
 Connell, Sarah, 13.16  
 Conner, Benjamin, 32.9  
 Conroy, Glenn C, 8.17, 57[3:30]  
 Constantino, Paul, 9.26  
 Cooke, Catherine A, 50.12  
 Cooke, Siobhan B, 8.20, 11.6, 19.2  
 Cooper, Alan, 5.10, 18[2:00]  
 Cooper, David, 32.1, 32.4  
 Coppa, Alfredo, 9.23  
 Corcione, Fabiana P, 52.27  
 Corley, Margaret K, 12.13  
 Cormier, Aviva A, 41.10  
 Cornejo, Fanny M, 2[8:00]  
 Cornelison, Jered B, 3[8:30]  
 Corny, Julien, 40.14  
 Cortes, John, 52.17  
 Cortés Ortiz, Liliana, 2[8:00, 8:30], 26[8:45]  
 Cortez, Amanda D, 52.40  
 Coscolla, Mireia, 2[11:15]  
 Cosman, Miranda, 31.28  
 Coss, Lisa, 6.9  
 Cossette, John, 26[9:30]  
 Costa, Paula Hentschel Lobo da, 34.28  
 Costello, Amanda K, 59[3:45]  
 Cote, Susanne, 57[Chair, 4:15]  
 Couette, Sebastien, 8.3, 36[1:00]  
 Cowen, Laura, 52.11  
 Cowgill, Libby W, 10.25, 19.13, 32.26  
 Cox, Laura A, 52.26  
 Cox, Samantha E, 20.6, 20.7  
 Craig, Oliver, 37[3:00]  
 Craig, Peter S, 30.30  
 Cramer, Jennifer D, 50.8  
 Cranfield, Michael R, 11.26, 31.42  
 Crawford, Dana, 44[8:30]  
 Crawford, Michael H, 13.6, 27.1, 27.2, 27.5  
 Creanza, Nicole, 5[9:20]  
 Crenshaw, Thomas D, 1[8:15]  
 Crespo, Fabian A, 34.38, 47[9:15]  
 Crews, Douglas E, 13.21, 34.22  
 Critcher, Lori T, 9.4  
 Crofoot, Margaret C, 7.1  
 Cronk, Lee, 7[Discussant]  
 Crouse, Kristin N, 33.14  
 Crowley, Brooke E, 1[10:45], 8.5, 25[8:45], 52.38  
 Csakyova, Veronika, 13.17  
 Csoz, Aranka, 13.17  
 Cucina, Andrea, 53.20  
 Cuddihy, Anastashia M, 14.9  
 Cullen Doyle, Allison P, 10.29  
 Cummings, Daniel, 1[11:30]  
 Cunha, Eugénia, 10.17, 38[2:45]  
 Cuozzo, Frank P, 11.22, 52.8  
 Cupples, L A, 27.17  
 Curate, Francisco, 3[11:30], 10.17  
 Curran, Joanne E, 27.10  
 Curran, Sabrina C, 56.3  
 Curtis, Emma K, 31.13  
 Cybulski, Jerome S, 13.10  
 Czeisler, Charles D, 58[3:15]
- D**  
 Daegling, David J, 11.15, 31.10, 31.40  
 Dagosto, Marian, 19.1, 36[2:00]  
 Dahl, Jeremy F, 60[4:30]  
 Dalén, Love, 2[11:30]  
 Daly, E. Susanne, 11.5  
 D'Anastasio, Ruggero, 59[4:00]  
 Daneshvari, Shamsi, 48[11:30]  
 Danforth, Marie E, 9.22  
 Danielson, Brent J, 52.35  
 D'Août, Kristiaan, 34.28  
 Darr, Maria R, 17[1:30]  
 Dávalos, Victor, 12.13  
 Davis, Christopher A, 17[1:30], 39[3:45]  
 Davis, Erica R, 8.33  
 Dawrueng, Thanee, 52.31  
 Deane-Drummond, Celia, 56.11  
 Deane, Andrew S, 11[Chair], 11.10, 31.17  
 de Becdelievre, Camille, 24[8:00]  
 Dechow, Paul C, 11.12, 30.7, 30.8  
 Decker, Summer J, 9.16  
 Degehardt, Susanne, 9.42  
 Deimel, Caroline, 60[4:15]  
 de Jong, Hylke, 55.22  
 De la Cova, Carlina, 21[Discussant]  
 de la Iglesia, Horacio O, 58[3:15]  
 DeLeon, Valerie B, 12.12, 30.15, 36[Chair, 2:45]  
 Delezene, Lucas K, 11.20  
 Delgado, Jr., Roberto A, 33.4  
 Delgado, Roberto A, 45[8:45]  
 Delson, Eric, 8.21, 8.24, 8.26  
 De Luca, Dan W, 59[2:45]  
 deMartelly, Victoria, 1[9:45]  
 Dembo, Mana, 30.16  
 Demes, Brigitte, 16[2:15], 17[3:15], 23[11:30, 11:45]  
 Demeter, Fabrice, 22[11:15]  
 Demps, Kathryn, 7.7  
 De oliveira e silva, Ita, 52.29  
 de Oliveira, Felipe B, 2[9:00]  
 DeRosa, Kate, 35.10  
 de Ruyter, Darryl J, 30.7, 30.8, 30.14, 30.17  
 Deschner, Tobias, 60[2:00, 4:15]  
 DeSilva, Jeremy M, 15[1:45], 16[2:00], 30.5  
 Deter, Chris, 14.12  
 Dettman, David L, 9.34  
 Dettmer, Amanda M, 12.4  
 Detwiler, Charles K, 33.20  
 Detwiler, Kate M, 33.20, 52.14, 52.15, 52.24  
 Dettwyler, Katherine, 41[Discussant]  
 Devlin, Maureen J, 38[3:15]  
 Devor, Eric J, 27.8  
 de Vries, Dorien, 56.4  
 DeWitt, Thomas J, 30.17  
 DeWitte, Sharon N, 9.36, 28.8, 47[9:15]  
 Dias, Pedro A. D, 26[8:45]  
 Diaz Lameiro, Alondra M, 2[11:45]  
 Dickinson, Alex, 11.8  
 Dickinson, Federico, 49.1  
 Di Fiore, Anthony, 2[8:30], 12.13, 33.30, 33.34, 33.37  
 DiGangi, Elizabeth A, 41.9  
 DiMichele, Daniel L, 32.37  
 Dingess, Kimberly A, 33.35  
 Ding, Julie, 32.33, 55.4  
 Dinsmore, Mary P, 52.9  
 Diogo, Rui, 4[8:00]  
 Disotell, Todd R, 2[11:00], 36[2:30], 52.42  
 Ditchfield, Peter W, 39[2:30]  
 Doherty, Alison H, 31.39  
 Dohmann-Pfälzner, Heike, 9.42  
 Domínguez-alonso, Patricio, 22[10:30]  
 Dominguez-Bello, Maria Gloria, 52.27  
 Dominguez, Victoria M, 9.38, 32.8, 53.7  
 Dominy, Nathaniel J, 45[11:00], 54.14  
 Donley, Gwendolyn A, 13.21  
 Donovan, Ronan, 4[11:15]  
 Doran-Sheehy, Diane M, 33.2  
 Dore, Kerry M, 52.22  
 Douglas, Pamela Heidi, 60[2:00]  
 Dove, Eleanor R, 55.9, 55.11  
 Dowdeswell, Mark R, 30.3, 39[1:45]  
 Doyle, L. Elizabeth, 55.5  
 Drapeau, Michelle S. M, 32.10, 32.18  
 Drew, J A, 50.10  
 Drury, Stacy S, 34.5  
 Dubuc, Constance, 4[11:30]  
 Dudas, Katherine, 35.3  
 Dudley, Robert, 45[9:45]  
 Duffy, Jeanne F, 58[3:15]  
 Duggirala, Ravindranath, 27.10  
 Dumouchel, Laurence, 30.6  
 Dunham, Noah T, 31.20  
 Dunkel, Lynda P, 45[9:30]  
 Dunn, Rachel H, 42.8, 56.6  
 Dunn, Tyler E, 32.36  
 Dunsworth, Holly M, 1[8:45], 15[1:30], 51[Discussant]  
 Dupanloup, Isabelle, 18[1:00]  
 Dupras, Tosha L, 9.15, 14.2, 14.3  
 Duque, Ana C, 11.15  
 Durband, Arthur C, 9.20, 9.27, 32.12  
 Durchholz, Aaron M, 53.15  
 Durham, Emily L, 36[3:15]  
 Durringer, Philippe, 22[11:15]  
 Dziebel, German V, 13.1
- E**  
 East, Kaitlin E, 9.15  
 Eckels, Howard T, 59[2:45]  
 Eckhardt, Robert B, 35.19, 35.20  
 Eddy, Sarah L, 47[8:00]  
 Edgar, Heather JH, 9.30, 34.21, 40.12  
 Edge, Michael D, 44[11:15]  
 Edleson, Kristi, 18[1:45]  
 Edmonds, Hallie M, 31.34  
 Edwards, Melissa, 5.8  
 Ehardt, Carolyn L, 26[11:00], 33.25  
 Eisenberg, Dan T.A, 27.9  
 Eleazer, Courtney D, 14.3  
 Elera, Carlos, 9.12  
 Elias, Jonathan P, 9.2  
 Eller, Andrea R, 31.31, 31.32, 38[1:00], 56.5  
 Elliott, Marina C, 19.11  
 Ellison, Peter T, 1[Discussant], 54.8, 58[3:00]  
 el-Maksoud, Gomaa Abd, 20.6  
 Elton, Sarah, 8.11  
 Ely, John J, 1[9:15]  
 El Zaatari, Sireen, 22[Chair, 9:00]  
 Emerson, Charles W, 8.17

- Emery Thompson, Melissa, 1[10:30, 10:45], 26[10:30], 45[9:30], 60[3:15]  
 Emery, Michael M, 55.11  
 Endicott, Kirk M, 37[1:30], 54.14  
 Endicott, Phillip, 54.14  
 Engel, Felix, 53.18  
 England, Todd, 34.14  
 Enriquez-de-Salamanca, Mercedes, 13.5  
 Eppler, Elisabeth, 53.5  
 Erb, Wendy M, 1[10:45], 33.37, 45[9:30]  
 Eriksen, Amandine B, 31.42  
 Erksenswick, Gideon A, 52.29, 54.1, 60[2:15]  
 Erlandson, Jon M, 48[10:15]  
 Ersmark, Erik, 2[11:30]  
 Evans, Sian, 33.36  
 Ewald, Paul W, 54.4  
 Excoffier, Laurent, 18[1:00]  
 Eyana Ayina, Crepin, 26[9:00]  
 Eyre, Jennifer, 31.26
- F**
- Fairbanks, Lynn, 26[10:15]  
 Falk, Dean, 15[2:45], 39[3:30]  
 Fan, Jian-Bing, 27.16  
 Faraldo, Monica, 53.32  
 Farber-Eger, Eric, 44[8:30]  
 Fardi, Sara A, 52.10  
 Farine, Damien, 7.1  
 Farkašová, Kristýna, 55.16  
 Farook, Vidya S, 27.10  
 Fazlollah, Alice E, 32.14  
 Fedigan, Linda M, 4[8:45, 11:00], 45[9:15]  
 Fedorova, Valentina I, 27.18  
 Fehren-Schmitz, Lars, 18[2:00], 59[2:45]  
 Feldblum, Joseph T, 4[9:30]  
 Feldman, Marcus W, 5[9:20]  
 Femenias-Gual, Joan, 8.1  
 Feng, Ziding, 27.16  
 Fernandes, Daniel M, 13.16  
 Fernandez, Aileen, 53.8  
 Fernandez, Catalina I, 13.12  
 Fernandez, Peter J, 30.22  
 Fernandez-Duque, Eduardo, 12.13, 33.34, 58[3:15]  
 Fernández-Honrad, Mercedes, 13.5  
 Fernández-jalvo, Yolanda, 22[10:30]  
 Fernee, Christianne, 11.8  
 Ferrari, Giada, 13.4  
 Ferrell, Rebecca, 11.14, 11.16  
 Fiddymment, Sarah, 37[3:00]  
 Field, Sean P, 14.5  
 Finarelli, John A, 40.15  
 Finch, Caleb E, 20.6, 20.7  
 Findley, Mary Kate, 33.10  
 Fischer, Roman, 37[3:00]  
 Fish, Kindra J, 34.7  
 Fish, Krista, 52.2, 52.8  
 Fisher, James A. L., 34.35  
 Fitzl, Christine, 53.13  
 Fitzpatrick, Molly C, 52.4  
 Fitzpatrick, Scott M, 13.13  
 Flaherty, Kevin V, 34.3  
 Fleagle, John G, 36[Discussant]  
 Flohr, Stefan, 9.42, 11.2  
 Flores, Sergio V, 3[8:45], 13.12, 13.22  
 Foerster, Steffen, 29.9  
 Fogelson, Shai Y, 33.15  
 Fornai, Cinzia, 35.4
- Fort, Matthew A, 6.3  
 Foster, Adam D, 31.11  
 Fotakis, Anna, 37[3:00]  
 Fournier, Nichole A, 5.11  
 Fox, Caroline S, 27.17  
 Fox, David L, 25[11:45], 52.13  
 Fox, Maria C, 35.11  
 Fox, Stephanie A, 33.26, 60[2:30]  
 Franciscus, Robert G, 35.8, 55.12  
 Francken, Michael, 10.16  
 Franke, Inge, 53.5  
 Frankenberg, Susan R, 28.1, 40.10  
 Franklin, Jay D, 38[3:30]  
 Franks, Erin M, 23[8:45]  
 Freed, Benjamin Z, 42.7  
 Freidin, Nicholas, 9.26  
 Freimer, Nelson B, 2[9:30, 9:45], 26[10:15]  
 Friant, Sagan, 45[9:00]  
 Friend, Amanda N, 53.23  
 Friess, Martin, 40.14  
 Froehle, Andrew W, 57[4:45]  
 Frohlich, Bruno, 20.6, 20.7  
 Frommlet, Florian, 53.13  
 Frost, Laura, 53.31  
 Frost, Stephen R, 8.19, 8.21, 8.24, 8.26, 31.31, 31.32, 31.33, 38[1:00], 56.5  
 Fuchs, Katharina, 3[10:15]  
 Fuentes, Agustin, 52.17, 52.23, 56.11  
 Fünfstück, Tillmann, 2[9:15]  
 Funkhouser, J. Lynn, 9.37
- G**
- Gagneux, Sebastien, 2[11:15]  
 Gagnon, Celeste Marie, 10.2  
 Galbany, Jordi, 12.6  
 Galbarczyk, Andrzej, 34.2, 34.10, 37[2:15, 3:45], 58[3:00]  
 Galeta, Patrik, 9.8  
 Galland, Manon, 40.14  
 Garcia, Angela, 47[9:30]  
 García-González, Rebeca, 19.8, 43[9:45, 10:30]  
 Gareca, Yuvinka, 33.35  
 Garfield, Melissa, 37[1:15]  
 Garfield, Zachary H, 7.7, 54.9  
 Garland, Carey J, 14.8, 14.10  
 Garrett, Eva C, 25[9:45]  
 Garrison, Nanibaa' A, 13.2  
 Garvie-Lok, Sandra, 24[8:15]  
 Garvin, Greg, 59[3:30]  
 Garvin, Heather M, 34.12, 34.19  
 Garza, Ruben, 51.5  
 Gassler, John, 34.24  
 Gaugler, Luke, 52.8  
 Gaulin, Steven J.C, 34.11  
 Gautney, Joanna R, 35.17  
 Géant-Caparrós, Lucile, 11.28  
 Geber, Jonny, 24[9:15]  
 Gebo, Dan, 19.1, 36[2:00]  
 Geissler, Elise, 11.15  
 Geller, Pamela L, 59[3:00]  
 Gengo, Rieti G, 3[9:00]  
 Gentner, Lorraine S, 11.30  
 George, Ian D, 58[3:30]  
 Georgiev, Alexander V, 26[10:30]  
 Gerkey, Drew, 7.6  
 Germain, François, 11.28  
 Gettings, Katherine, 27.7  
 Gettler, Lee T, 15[3:00]
- Getz, Sara M, 53.2  
 Gibbs, Sherry, 28.11  
 Gibson, Rebecca, 38[3:45]  
 Gilbert, Christopher C, 8.21, 8.24, 8.25, 8.26  
 Gilbert, M Thomas P, 37[3:00]  
 Gilby, Ian C, 4[9:30, 11:15], 7.4, 26[11:30], 29.9  
 Gildner, Theresa E, 34.23, 34.32, 58[2:00, 2:15]  
 Gladman, Justin T, 8.9  
 Glantz, Michelle, 22[10:45]  
 Glass, Holly, 13.2  
 Glaze, Evelyn S, 11.9  
 Glencross, Bonnie A, 3[9:15]  
 Glenn, Mary E, 52.20  
 Glenzer, Rachel R, 56.5  
 Glover Klemetti, Susan, 7.7  
 Glowacka, Halszka, 11.11  
 Glowacki, Luke, 7[Chair], 7.8, 7.10  
 Gocha, Timothy P, 32.3  
 Godde, Kanya, 9.18, 10.12, 53.10  
 Godfrey, Laurie R, 8.5, 25[8:45], 42.4, 42.9, 45[10:45], 52.1, 52.38  
 Gogarten, Stephanie M, 27.14  
 Goldberg, Amy, 5[Chair], 5.4  
 Goldberg, Tony L, 45[9:00], 52.21  
 Golde, Katherine M, 24[9:00]  
 Goldstein, Lynne, 28.5  
 Goliath, Jesse R, 53.14  
 Golombek, Diego A, 58[3:15]  
 Gomberg, Emmalea E, 9.22  
 Gomez, Andres M, 2[10:15]  
 Gomez, Felicia, 13.23  
 Gómez-Olivencia, Asier, 43[9:15]  
 Gomula, Aleksandra, 34.26, 47[8:30, 8:45]  
 Gonciar, Andre, 11.34  
 Gonzales, Lauren A, 8.18  
 Gonzalez, Tomas B, 3[8:45]  
 Goodheart, Michael J, 27.8  
 Goodman, Lauren D, 53.32  
 Goodreau, Steven M, 47[8:00]  
 Gooley, Michelle, 55.25  
 Gopher, Avi, 35.4  
 Gordon, Adam D, 33.38  
 Gosman, James, 17[2:15], 32.9, 38[2:00], 55.14  
 Goude, Gwenaëlle, 24[8:00]  
 Gould, Lisa, 52.11  
 Gozalo, Alfonso S, 54.1  
 Grabowski, Mark W, 8.31, 30.18, 39[Chair, 1:15], 57[2:45]  
 Gracia-Tellez, Ana, 43[10:45]  
 Graff, Misa, 27.14, 27.17  
 Graham, Deborah, 53.22  
 Graham, Sophia, 4[11:30]  
 Granatosky, Michael C, 23[9:45, 10:30], 31.15  
 Grarup, Niels, 27.17  
 Grass, Andy D, 35.8  
 Grativol, Adriana D, 2[10:30], 52.29  
 Gravlee, Clarence C, 34.4, 44[9:00, 9:15]  
 Green, Daniel R, 30.29  
 Green, David J, 57[4:00]  
 Green, Gregory M, 30.29  
 Gregoricka, Lesley A, 59[3:15]  
 Greiner, Thomas M, 31.1  
 Gresky, Julia, 3[9:45, 10:15], 10.27  
 Ggurich, Tania, 59[2:45]  
 Grider-Potter, Neysa, 30.2, 36[3:30]  
 Griego, Anthony, 59[2:45]



- Grine, Frederick E, 11.19, 30.10, 39[2:15], 56.4  
 Groner, Victoria, 18[1:45]  
 Gross, Jessica M, 13.20, 44[8:15]  
 Grosse, Ian R, 30.7, 30.8  
 Grossman, Lawrence I, 1[9:00]  
 Grote, Mark N, 5.13, 12.3  
 Grow, Nanda B, 33.43  
 Gruenthal-Rankin, Ariel, 9.29  
 Grundy, Bryan, 52.2  
 Grunspan, Daniel Z, 47[8:00]  
 Guatelli-Steinberg, Debbie, 10.11, 11.14, 11.16, 11.17, 11.26  
 Guevara, Elaine E, 52.33  
 Guise Sheridan, Susan, 9.13, 9.14, 24[11:30]  
 Gumerman, George J, 24[9:45]  
 Gumert, Michael D, 33.19, 52.23  
 Gunnell, Gregg F, 25[8:15], 36[1:45]  
 Gunz, Philipp, 16[3:15], 57[4:00]  
 Guo, Lin, 53.19  
 Gursky, Sharon, 36[Chair, 1:15, 1:30]  
 Gurven, Michael, 1[11:30], 4[9:15], 7.9, 34.11, 37[2:00, 2:30], 58[4:00]  
 Guthrie, Emily H, 8.24  
 Gutierrez, Estevan, 22[11:00]  
 Gwyer, Janet, 50.6
- H**  
 Haack, Karin, 27.12  
 Haak, Wolfgang, 5.10, 18[2:00]  
 Habicht, Michael, 53.11  
 Hackner, Stacy L, 9.7  
 Hadley, Craig A, 58[2:45]  
 Hadly, Elizabeth A, 5.4  
 Haeusler, Martin, 16[2:30], 57[2:15]  
 Hafner, Albert, 54.13  
 Hagen, Edward H, 7.7, 37[Chair, 1:15], 54.2, 54.9  
 Hahn, Beatrice H, 4[9:30]  
 Haile-Selassie, Yohannes, 56.3  
 Haileselassie, Sewasew, 10.28  
 Halberstein, Robert A, 27.19  
 Halenar, Lauren B, 8.10, 19.2  
 Halfman, Carrin M, 55.19  
 Hall, Sarah A, 32.17  
 Hallgrimsson, Benedikt, 57[3:45]  
 Halling, Christine L, 11.33, 28.11  
 Halloran, Andrew R, 50.3, 52.36, 52.37  
 Hamilton, Marian I, 56.12  
 Hammerl, Emily E, 55.15, 55.17  
 Hammond, Ashley S, 8.37  
 Hansen, Bethany K, 26[11:15]  
 Hansen II, David W, 11.34  
 Hanson, Kari L, 15[2:30]  
 Hanson Sobraske, Katherine N, 34.11  
 Hardin, Anna M, 11.29  
 Hare, Brian, 33.42  
 Hargrave, Eve A, 6.1, 6.7, 6.8, 28.6  
 Harkins, Kelly M, 2[11:15]  
 Harney, Eadaoin, 5.10  
 Harper, Gareth, 53.5  
 Harper, Kristin N, 3[8:15], 10.14  
 Harrington, Arianna R, 8.6  
 Harris, Tara R, 4[9:00]  
 Harrison, Jessica L, 6.9  
 Harrison, Terry, 8.40, 30.21, 31.6  
 Hart, John A, 52.14  
 Harvati, Katerina, 10.16, 22[Chair, 9:15], 31.6, 56.8  
 Hatala, Kevin G, 30.18, 39[1:15, 1:30, 2:00]  
 Hatch, Mallorie A, 6.8  
 Haueisen, Sarah, 2[11:00], 52.42  
 Havill, Lorena M, 5.3, 52.19  
 Hawkesworth, Chris, 55.22  
 Hawks, John, 51.4  
 Hayes, M. Geoffrey, 5.14, 13.6, 27.4, 44[11:30]  
 Hays, Lindsey, 31.17  
 Hayward, Adam D, 58[2:30]  
 Healy, Carrie A, 35.6  
 Heard-Booth, Amber N, 17[1:45]  
 Heard-Costa, Nancy L, 27.17  
 Hedman, Kristin M, 6[Chair], 6.1, 6.3  
 Hefner, Joseph T, 40[Chair], 40.1  
 Heim, Kelly N, 40.9  
 Heins, Sarah E, 10.10  
 Hendy, Jessica, 37[3:00]  
 Henn, Brenna M, 18[1:00]  
 Henneberg, Maciej, 3[11:00], 34.14, 35.19, 35.20, 53.11, 53.17, 53.28, 59[4:15]  
 Henneberg, Renata J, 3[11:00]  
 Henry, Amanda, 37[3:30]  
 Hens, Samantha M, 9.18, 10.12, 53.10  
 Henson, Kristy D, 9.26  
 Herbig, Alexander, 2[11:15]  
 Herling, Patrick, 34.24  
 Hernandez, Diego A, 50.15  
 Hernani-Lineros, Lucero M, 33.37  
 Herrera, Brianne, 34.36, 37[3:15]  
 Herrera, James P, 12.16, 52.7  
 Herrera, Kristian J, 18[1:30]  
 Herrera, Rene J, 18[1:30]  
 Herrera Paz, Edwin F, 27.2  
 Herries, Andy I.R, 30.27  
 Herrmann, Nicholas P, 9.6, 38[3:30], 53.21  
 Herrscher, Estelle, 24[8:00]  
 Hershkovitz, Israel, 17[2:30], 35.4  
 Hertler, Christine, 22[8:15]  
 Hevia, Macarena, 13.12  
 Heyd, Volker, 55.22  
 Higgins, Rosanne L, 14.17  
 Higgs, Brittany L, 10.14  
 Higham, James P, 4[11:30], 31.35, 33.24  
 Highland, Heather M, 27.17  
 Highsmith, Lisa C, 10.19  
 Highsmith, Melanie L, 53.29  
 Hildebolt, Charles F, 39[3:30]  
 Hiles, Shannon, 17[3:00]  
 Hill, Ethan C, 9.20, 32.12  
 Hillier, LaDeana, 2[9:30]  
 Hinde, Katie, 1[10:15], 12.3, 38[1:15], 50.10  
 Hirasaki, Eishi, 23[9:00, 10:45], 31.16  
 Hirwa, Jean Paul, 4[11:45]  
 Hiwatashi, Tomohide, 4[11:00]  
 Hlusko, Leslea J, 39[3:00], 49.2  
 Hodges-Simeon, Carolyn R, 34.11  
 Hodgson, Jason A, 18[3:30]  
 Hoerman, Rachel, 22[11:30]  
 Hof, Patrick R, 1[9:00, 9:15], 33.8  
 Hoff, Aliya R, 9.35  
 Hogg, Russell T, 1[8:15]  
 Hohmann, Gottfried, 29.7, 60[2:00, 4:15]  
 Holder, Sammantha, 14.2  
 Holland, Alyson, 21[Chair], 21.11  
 Holliday, Trenton W, 34.29, 35.17  
 Hollister, Brittany M, 44[8:30]  
 Hollocher, Hope, 52.23  
 Holloway, Ralph L, 16[3:00], 46[11:15, 11:30]  
 Holmes, Andrew C, 31.2  
 Holmes, Megan A, 23[8:00]  
 Holowka, Nicholas B, 23[11:30, 11:45]  
 Holt, Brigitte, 19.12, 19.14, 32.21  
 Holton, Nathan E, 32.31  
 Honap, Tanvi P, 13.8, 52.29  
 Honn, Denise, 53.22  
 Hooper, Paul L, 7.5  
 Hoover, Kara C, 14[Chair], 14.7  
 Hope, Kellen N, 54.11  
 Hopkins, William D, 4[8:15], 33.8, 57[4:30]  
 Hoppa, Robert D, 9.2  
 Hora, Martin, 35.14, 55.16  
 Houk, Brett, 9.27  
 Housman, Genevieve, 52.19, 52.29  
 Hové, Carmen M, 34.27  
 Howard, Barbara V, 27.12  
 Hruschka, Daniel J, 58[2:45]  
 Hsieh, Fushing, 45[8:00]  
 Huang, Hong, 27.11  
 Huang, Susan, 25[8:00]  
 Hubbard, Amelia R, 9[Chair], 9.11  
 Hubbell, Zachariah R, 17[2:15], 55.14  
 Hubbe, Mark, 9.1, 10.8, 11.16, 24[11:00], 34.36  
 Hublin, Jean-Jacques, 35.2, 43[11:00]  
 Huck, Maren, 12.13  
 Huffman, Michaela M, 11.1  
 Hughes-Morey, Gail M, 55.3  
 Hughes, Cris E, 5.1, 13.10  
 Hulse, Courtney, 34.13  
 Hulse, Brannon I, 5.3, 28.15, 40.4  
 Humphrey, Caitlin L, 53.28  
 Humphrey, Louise, 35.5  
 Humphries, Ashley L, 10.30  
 Hunley, Keith, 5[9:00], 5.12  
 Hunold, Holly J, 50.7  
 Hunt, David R, 31.42, 32.37, 53.8  
 Hunt, Kevin D, 46[11:30]  
 Hunter, Carla D, 47[8:15]  
 Hunter, Randee L, 32.6  
 Hurlbert, Donald E, 9.10  
 Hurst, Shawn D, 16[3:00], 46[Chair, 11:15, 11:30]  
 Hurtubise, Jenna R, 14.9  
 Hutchinson, Dale L, 54.12  
 Huysecom, Eric, 22[8:00]  
 Hylander, William L, 16[3:30], 43[8:45]
- I**  
 Ikram, Salima, 45[11:00]  
 Indriati, Ety, 37[2:45]  
 Ingleman, David A, 41.3  
 Ingmanson, Ellen J, 33.5  
 Inskip, Sarah A, 41.4  
 Ioannou, Stella, 3[11:00]  
 Iriarte-Diaz, Jose, 11.21, 23[8:15], 31.36  
 Irish, Joel D, 40.6, 55.9  
 Irwin, Mitchell T, 34.35, 52.3, 52.4  
 Isabel ochoa-lugo, Mirna I, 27.3  
 Isassi, Carmen, 27.14  
 Isbell, Lynne, 29[Discussant]  
 Ito, Tsuyoshi, 31.41
- J**  
 Jabbour, Rebecca S, 31.14, 32.33, 55.4  
 Jack, Katharine M, 4[11:00], 45[9:15]  
 Jackson, Derek A, 45[8:15]

- Jackson, Kathryn L, 44[11:30]  
 Jacobi, Keith P, 10.4  
 Jacobs, Rachel L, 2[8:45]  
 Jaeggi, Adrian V, 4[9:15]  
 Jakob, Tina, 10.9, 20.3  
 James, Gary D, 34.8  
 Jang, Yikweon, 42.11  
 Jankauskas, Rimantas, 14.2, 14.3  
 Jansma, Rutger J. W, 8.35  
 Jantz, Lee M, 40.13  
 Jantz, Richard L, 40.13, 53.21  
 Jashashvili, Tea, 30.3, 30.23, 39[1:45]  
 Jasienska, Grazyna, 34.2, 34.10, 37[2:15, 3:45], 58[3:00]  
 Jasinska, Anna J, 2[9:30, 9:45], 26[10:15]  
 Jayasri, Srikantan L, 33.19  
 Jelenc, Kelsey E, 32.28  
 Jenkinson, Christopher P, 27.10  
 Jensen, Anne, 5.14  
 Jeong, Yangseung, 10.24, 19.17  
 Jewett, Ethan M, 5.6  
 Jimenez, Eric B, 18[1:30]  
 Jindrová, Alena, 31.12  
 Joganic, Jessica L, 2[9:00]  
 Johannesdottir, Erna, 48[10:30]  
 Johannesdottir, F., 19.16  
 Johnson, Paul M, 23[9:00]  
 Johnson, Stephen M, 30.30  
 Johnson, Zachary P, 2[10:45], 29.5  
 Johnston, Rob'yn A, 10.25  
 Jones, Daniel S, 24[11:45]  
 Jones, James H, 47[9:00]  
 Jones-Engel, Lisa, 52.17, 52.23  
 Jorgensen, Matthew J, 2[9:30, 9:45]  
 Jovanović, Jelena, 24[8:00]  
 Juarez, Chelsey A, 9.33  
 Judd, Margaret A, 10.29  
 Judex, Stefan, 17[3:15]  
 Jung, Hyunwoo, 10.24, 53.3  
 Jungers, William L, 16[2:45], 25[8:30], 30.22, 39[1:15, 2:15, 3:30]  
 Junno, Juho-Antti, 19.12, 19.14  
 Justice, Anne E, 27.14, 27.17
- K**  
 Kaas, Jon H, 8.16, 36[3:00]  
 Kaestle, Frederika A, 6.9  
 Kaiser, Jessica E, 59[4:30]  
 Kamenov, George D, 24[11:45], 59[2:45]  
 Kamilar, Jason M, 12.11, 42.9  
 Kamjing, Anucha, 52.31  
 Kamnikar, Kelly R, 10.14, 38[3:30]  
 Kane, Erin E, 29.6, 31.20, 52.34  
 Kanz, Fabian, 53.13, 55.6  
 Kaplan, Hillard, 1[11:30], 4[9:15], 7.5, 7.9, 37[2:00, 2:30], 58[4:00]  
 Kaplan, Jay R, 2[9:30, 9:45]  
 Kappelman, John, 39[3:45], 42.5, 51.5  
 Karabowicz, Amy N, 55.20  
 Karaderi, T, 27.17  
 Karban, Miranda E, 35.8  
 Karkanas, Panagiotis, 22[9:45]  
 Karsten, Jordan K, 10.10  
 Kasabova, Boryana E, 34.29  
 Kasparov, Alexei K, 13.3  
 Katz, David C, 5.13  
 Katzenberg, M. Anne, 10.6, 24[8:15]  
 Kauffman, Laurie, 50[Chair], 50.5  
 Kawai, Aya, 37[1:30]  
 Kawamura, Shoji, 4[8:45, 11:00]  
 Kay, Richard F, 8.18, 25[10:15]  
 Keenan, Kendra E, 32.5, 55.23  
 Kegley, Anthony D.T, 30.27  
 Keinan, Alon, 18[1:15]  
 Keller, Andreas, 20.7  
 Kelley, Jane H, 10.6  
 Kelly, Emma, 13.2  
 Kennedy, Jennifer G.L, 13[Chair], 13.15  
 Kensler, Terry B, 11.12  
 Kenyhercz, Michael W, 34.13, 40.3  
 Kerker, Lana M, 52.5  
 Kertes, Darlene A, 34.4  
 Kessler, Matthew J, 11.12  
 Kessler, Sharon E, 25[Chair, 9:15]  
 Key, Alastair J. M, 30.26  
 Kgasi, Lazarus, 30.27  
 Khartanovich, Valery I, 3[11:15], 13.3  
 Kho, Abel N, 44[11:30]  
 Kidd, Jeffrey M, 18[1:00]  
 Kierdorf, Horst, 11.2  
 Kierdorf, Uwe, 11.2  
 Killgrove, Kristina, 50.11  
 Killough, Meredith L, 31.42  
 Kimmerle, Erin H, 10.30  
 Kinaston, Rebecca L, 24[8:45]  
 King, Jason L, 28.4  
 King, Tania, 22[10:30]  
 King, Samantha I, 20.6  
 Kingsley, David M, 25[10:45]  
 Kingston, Amanda K, 31.22  
 Kingston, John, 12.5, 25[11:15], 30.28  
 Kirchhoff, Claire A, 11.31  
 Kirera, Francis M, 39[2:45]  
 Kirk, E. Christopher, 25[9:45]  
 Kirkpatrick, Casey L, 21.10  
 Kirwin, Carolyn, 34.1  
 Kissel, Marc, 56.11  
 Kistler, Logan, 25[8:45]  
 Kitchen, Andrew, 50.14  
 Kitchen, Dawn M, 26[8:45]  
 Kittles, Rick A, 44[9:45]  
 Kittoe, Amanda G, 59[2:15]  
 Kityo, Robert, 12.5  
 Kiura, Purity, 39[1:30]  
 Kivell, Tracy L, 32.11  
 Klaes, Chris K, 47[9:15]  
 Klales, Alexandra R, 9.2  
 Klaus, Haagen, 9.12, 14.8, 14.9, 14.10, 24[10:30], 48[10:45]  
 Klegarth, Amy R, 52.23  
 Klimek, Magdalena, 37[3:45], 58[3:00]  
 Klimova, Tatiana M, 27.18  
 Knigge, Ryan P, 8.41  
 Knight, Rob, 52.30  
 Knott, Cheryl, 1[10:45], 4[8:30], 26[Chair, 11:45]  
 Knowles, Kevin C, 11.36  
 Knudson, Kelly J, 24[10:15]  
 Knyf, Martin, 48[11:45]  
 Knüsel, Christopher J, 3[9:15]  
 Koda, Hiroki, 31.41  
 Koehl, Anthony J, 18[3:45], 44[8:15]  
 Koenig, Andreas, 4[10:45], 12.9, 33.27, 60[3:30]  
 Koenig, Bryan L, 33.19  
 Kohn, Jordan, 2[10:45], 29.5  
 Kohn, Luci, 31.25  
 Kolb, Suzanne, 27.16  
 Kolpashchikov, Dmitry M, 9.15  
 Konigsberg, Lyle W, 5[Discussant], 8.30, 28[Discussant], 28.1, 40.10  
 Koops, Kathelijne, 26[9:30]  
 Koperkiewicz, Arkadiusz, 9.29  
 Kopp, Derinna V, 31.19  
 Koppe, Thomas, 25[9:00]  
 Kordek, Anna C, 33.7  
 Korsgaard, Jessica G, 8.40  
 Kowal, Paul, 34.23, 34.32  
 Koziel, Sławomir, 34.26, 47[8:30, 8:45]  
 Kozma, Elaine E, 30.21  
 Kozłowski, Tomasz, 3[10:30]  
 Kraft, Thomas S, 37[1:30]  
 Krajewska, Magdalena, 3[10:30]  
 Kramer, Karen L, 1[9:30]  
 Kramer, Patricia A, 32.20, 32.23, 32.25, 32.27, 34.34, 50.4  
 Krause, Johannes, 2[11:15], 20.7  
 Kravtsova, Olga A, 3[11:15]  
 Kreutzer, Susanne, 18[2:45]  
 Krigbaum, John, 13.13, 59[2:45]  
 Kristjanson, Heather L, 8.2  
 Krivoshapkin, Vadim G, 27.18  
 Kropp, Sara M, 53.30  
 Krupenye, Christopher, 4[9:30], 29.9, 33.42  
 Kuhlman, Gabriel F, 5.7  
 Kulhavy, Kathryn E. D, 28[Chair], 28.10  
 Kuo, Sharon, 34.12  
 Kurki, Helen K, 19.11, 21.5  
 Kusano, Yosuke, 34.22  
 Kusimba, Chaprukha, 9.24, 13.18, 13.19  
 Kuykendall, Kevin L, 11.25  
 Kuzawa, Christopher W, 1[Chair, 9:00], 44[8:45]  
 Kuzminsky, Susan, 18[2:00]  
 Kwiatt, Anne C, 52.17  
 Kwok, Cynthia S, 24[8:15]  
 Kyriakou, Xenia-Paula, 10.18, 10.19, 10.26, 10.28, 14.6
- L**  
 L'Abbé, Ericka N, 34.13  
 Labo, Philip T, 47[9:00]  
 Lacruz, Rodrigo S, 1[8:15]  
 Lacy, Sarah A, 35.1, 59[3:00]  
 Lad, Susan E, 31.10  
 Lague, Michael R, 57[3:15]  
 Laird, Myra F, 17[1:00]  
 Laliashvili, Irma, 18[1:45]  
 Laliashvili, Shorena, 18[1:45]  
 Lamar, Melissa, 1[9:45]  
 Lambert, Kelly G, 33.22  
 Lambert, Patricia M, 48[Chair, 10:15]  
 LaMontagne, Joshua, 9.33  
 Lancaster, Tracey, 8.22  
 Lander, Rebecca S, 34.37  
 Landis, Sabine, 57[2:15]  
 Landolt, Michaël, 11.28  
 Lanford, Robert E, 2[10:45]  
 Langdon, John H, 37[1:45], 58[4:15]  
 Lange, Nicholas, 1[9:00]  
 Langowski, Natalie, 24[10:45]  
 Langston, Tanner D, 32.5, 55.23  
 Lans, Aja M, 10.15  
 Lanza, Norberto, 58[3:15]  
 Laroque, Plautino O, 33.30  
 Larsen, Clark S, 10.11  
 Larson, Susan G, 23[9:30, 11:15]  
 Laston, Sandra, 27.12



- Laurie, Cathy, 27.14  
 Laurie, Cecelia, 27.14  
 Lautzenheiser, Steven G, 32.20, 32.23  
 Lawrence, Austin B, 10.20  
 Lawrenz, Matthew B, 47[9:15]  
 Lazaridis, Iosif, 5.10  
 Lazenby, Richard, 32.10, 32.18  
 Le, Kim N, 32.19  
 Le, Thanh X, 30.30  
 Leahy, Rachael E, 34.22  
 Leakey, Louise, 39[2:15]  
 Leakey, Meave G, 39[2:15]  
 Lease, Loren, 50.2  
 Ledogar, Justin A, 30.7, 30.8, 52.28  
 Lee, Amanda B, 8.30  
 Lee, Elisa T, 27.12  
 Lee, Esther J, 13.3  
 Lee, Katharine M, 34.2, 34.10  
 Leenheer, Elizabeth D, 13.19  
 Legesse, Belaineh, 54.3  
 Legge, Scott S, 11.29  
 Lehman, Clarence L, 33.14  
 Lehman, Donna M, 27.10  
 Leichter, Jennifer, 33.18  
 Leigh, Steven R, 2[10:15], 52.30  
 Leimberger, Kara G, 12.7  
 Leitman, Dale C, 4[9:00]  
 Leitner, Michael, 53.24  
 Lemaire, Edward, 41.7  
 Leonard, Chelsea, 37[3:30]  
 Leonard, William R, 1[9:00, 11:00], 15[Discussant], 27[Chair], 27.18, 37[2:45]  
 Leroy, Ailissa N, 52.14  
 Le roy, Mélie, 24[8:00]  
 Lesciotto, Kate M, 34.19  
 Leslie, Kimberly K, 27.8  
 Lesnik, Julie J, 35[Chair], 35.9  
 Levy, Stephanie B, 1[11:00]  
 Levy, Thomas E, 9.35  
 Lewis, Kati J, 50.9  
 Lewis, Margaret E, 42.6  
 Lewis, Rebecca J, 4[10:15, 10:30], 12.7  
 Lewton, Kristi L, 45[10:15], 50.10  
 Li, Dawei, 22[11:00]  
 Li, Hongjie, 52.43  
 Li, Jin Z, 23[11:30]  
 Li, Ly, 36[3:15, 3:45]  
 Li, Mocen, 54.7  
 Li, Zheng-Hua, 53.21  
 Liang, Ningning, 53.19  
 Lieberman, Daniel E, 17[Chair, 2:00, 3:30], 32.30  
 Liebert, Anke, 37[3:00]  
 Liebert, Melissa A, 34.23, 34.32, 58[2:00, 2:15]  
 Lieverse, Angela R, 21.4  
 Light, Lydia E.O, 52.32  
 Lima, João P, 10.17  
 Lindauer, Susanne, 18[2:00]  
 Lindgren, Cecelia, 27.17  
 Lindo, John, 5.2  
 Lindshield, Stacy M, 52.35  
 Link, Andres, 8.20, 33.34  
 Link, Karl, 53.5  
 Lipatov, Mikhail, 18[1:00]  
 Lipende, Iddi, 26[9:30]  
 Lipovich, Leonard, 1[9:00]  
 Litton, Scott M, 32.5  
 Liu, Chin-hsin, 50.13  
 Liu, Ching-Ti, 27.17  
 Liu, Ming, 9.21  
 Liu, Sean S-Y, 23[9:15]  
 Liversidge, Helen M, 38[1:45]  
 Livingood, Sarah V, 11.20  
 Llamas, Bastien, 5.10, 18[2:00]  
 Lloyd, Emily K, 33.25  
 Lockau, Laura, 21.9  
 Locke, Ellis M, 8.23  
 Lombardi, Guido P, 20.6, 20.7  
 Lombardo, Robert B, 59[2:45]  
 London, Marilyn, 50[Discussant]  
 Long, Jeffrey, 5[9:00], 13.20, 18[2:15, 3:45], 44[8:15]  
 Lonsdorf, Elizabeth V, 26[9:15, 9:30, 11:30], 33.9  
 Loos, Ruth J.F, 27.17  
 Lopes, Célia, 3[11:30]  
 Lopez-Torres, Sergi, 8.13  
 Lordkipanidze, David, 30.3, 30.23, 39[1:45]  
 Lorenzo, Carlos, 43[10:15]  
 Lösch, Sandra, 54.13  
 Loudon, James E, 33.18  
 Louis, Jr., Edward E, 25[8:45], 52.9  
 Lovejoy, C. Owen, 31.5, 31.29  
 Love-Myers, Kim, 53.6  
 Lowery, Robert K, 18[1:30]  
 Loyola, Laura C, 45[8:45]  
 Lu, Y, 27.17  
 Lucas, Teghan A, 59[4:15]  
 Ludeman, Elissa, 22[11:00]  
 Lummaa, Virpi, 58[2:30]  
 Luong, Albert, 52.27  
 Luttrell, Elizabeth, 52.8  
 Lycett, Stephen J, 13.7, 30.26  
 Lynch Alfaro, Jessica W, 2[8:30]  
 Lynnerup, Niels, 20[Discussant], 20.4, 37[3:00]
- ## M
- Macak, Kristin M, 10.12  
 MacCluer, Jean W, 27.12  
 MacDonald, Lisa J, 60[2:30]  
 Machado Pereira, Luiz Cezar, 52.29  
 Macháček, Jiří, 9.8  
 Machanda, Zarin, 1[10:30], 4[11:15], 7.4, 60[Chair, 2:45, 3:15]  
 Macintosh, Alison A, 55.1  
 Mackie, Meaghan, 37[3:00]  
 MacLachy, Laura, 8.35, 12.5, 25[11:15]  
 MacLean, Evan L, 33.42  
 Madar, Aviv, 18[1:15]  
 Madden, Gwyn D, 10.10  
 Maddux, Scott D, 32.35, 34.16  
 Madimenos, Felicia C, 37[2:30], 49[Chair], 49.4, 58[2:15]  
 Madrigal, Lorena, 27.11  
 Maestripieri, Dario, 4[11:30], 26[10:30], 33.24  
 Maggiano, Corey, 32.1  
 Maggiano, Isabel, 32.1, 32.4  
 Mahaney, Michael C, 27.10, 52.26  
 Maheny, Augustus E, 14.9  
 Mahoney, Patrick, 14.12, 32.11  
 Maier, Christopher A, 40.9  
 Maijanen, Heli, 19.12, 19.14, 19.17  
 Maiolino, Stephanie A, 25[8:00]  
 Maixner, Frank, 20.7  
 Makovicky, Pavol, 13.17  
 Malekfar, Lily, 10.21  
 Malhi, Ripan S, 5[9:40], 5.2, 5.9, 5.15, 6.10, 13.6, 13.10, 25[8:45], 34.10, 52.43  
 Malinzak, Michael D, 8.18  
 Mallick, Swapan, 5.10, 18[2:00]  
 Mallott, Elizabeth K, 5.9  
 Malone, Maire, 12.5  
 Malukiewicz, Joanna, 2[10:30], 52.29  
 Mamo, Martha, 54.3  
 Mandalaywala, Tara M, 33.24  
 Mangalu, Felista F, 49.2  
 Manhein, Mary H, 53.24  
 Mant, Madeleine L, 21[Chair], 21.3  
 Manthi, Fredrick K, 16[1:15], 25[11:45], 30.6  
 Maples, Brian K, 18[1:00]  
 Marchant, Linda F, 33[Chair], 33.10, 33.11  
 Marchi, Damiano, 9.5  
 Marciniak, Stephanie, 21.7  
 Marco, Javier, 13.5  
 Margolis, Julie A, 9.43  
 Marigó, Judit, 8.1  
 Marini, Elizabetta, 52.27  
 Märker, Michael, 22[8:15]  
 Markham, A. C, 26[11:30]  
 Marklein, Kathryn E, 24[11:00]  
 Marques, Carina, 3[11:30], 10[Chair], 10.23  
 Marsh, Hannah E, 10.31  
 Marshall, Andrew J, 45[10:30]  
 Marsteller, Sara J, 24[10:15]  
 Martell, Molly C, 12.12  
 Martelli, Sandra, 25[8:30]  
 Martin, Alicia R, 18[1:00]  
 Martin, Robert D, 37[1:00], 52.43  
 Martínez, Ignacio, 43[8:15, 10:45]  
 Martínez-meza, Adrian, 27.3  
 Martínez-Mota, Rodolfo, 52.30  
 Martiniakova, Monika, 13.17  
 Martínón-Torres, María, 43[9:00]  
 Martins, Amely B, 33.30  
 Marzke, Mary W, 33.11  
 Masao, Fidelis T, 39[3:00]  
 Masségli, Jane, 3[9:30]  
 Massimin, Jennifer L, 31.40  
 Masters, Michael P, 34.20  
 Mata-Míguez, Jaime, 13.9  
 Matarazzo, Stacey A, 57[3:00]  
 Mathena, Sarah A, 52.1  
 Mathews, Sandra, 16[2:30], 53.5  
 Mathieson, Iain, 5.10  
 Matos, Vitor M. J, 3[11:30], 10.17, 10.23  
 Matsuda Goodwin, Reiko, 52.20  
 Matsushita, Yuka, 4[8:45]  
 Maughan, Marisa A, 14.11  
 Mavroudas, Sophia R, 9.38  
 May, Hila, 17[2:30]  
 Mayall, Peter R, 9.3  
 May-Benson, Teresa A, 33.5  
 Mayer, Caitlin E, 10.18  
 Mays, Simon, 41.4  
 Mayus, Rebecca C, 9.13, 9.14  
 Mazur, Matthew M, 23[9:15]  
 Mbua, Emma N, 25[11:45]  
 McAbee, Kevin R, 23[8:45]  
 McAuliffe, Katherine, 7.8  
 McCabe, Collin M, 51.3  
 McCarthy, M M, 27.17  
 McCarthy, Robert C, 30.11, 35.3  
 McCarty, Christopher, 44[9:00]  
 McCowan, Brenda, 45[8:00]  
 McCrossin, Fiona G, 33.13

- McCrossin, Monte L, 8.33, 8.38  
 McCullough French, Katherine, 9.38  
 McCurry, Matthew, 8.28, 30.27  
 McDonald, Katherine, 6.4  
 McDonald, Monica M, 33.17  
 McFarlin, Shannon C, 11.26, 12.6, 31.42  
 McGough, Alexandra M, 32.33  
 McGrath, Francis, 51.5  
 McGrath, Kate, 11.26  
 McGraw, W. Scott, 11.15, 31.10, 31.20, 31.40, 52.34  
 McGrew, William C, 33.11  
 McGuire, Kaitlin, 53.1  
 McGuire, Sara A, 14.13  
 Mchulla, Mohammed, 9.24  
 McIlvaine, Britney Kyle, 10.5, 14.5  
 McKean, Margaret A, 45[10:45]  
 McKee, Jeffery, 30.25  
 McKenna, James J, 15[3:30]  
 McKenzie, Hugh G, 21.4  
 McKeown, Ashley H, 55.18  
 McLellan, Karen, 29.9  
 McNulty, Kieran P, 25[11:45], 30.17, 39[3:30]  
 Meador, Lindsay R, 42.4  
 Meador, Lindsey M, 33.12  
 Mears, Chad S, 32.5, 55.23  
 Meier, Rudolf, 52.23  
 Meijaard, Erik, 45[10:30]  
 Meikle, Eric, 51.10  
 Meinelt, Audra, 26[9:45]  
 Melin, Amanda D, 4[Chair, 8:45], 45[8:15]  
 Meller, Harald, 5.10, 55.22  
 Melton, Phillip E, 27.1, 27.5  
 Menard, Mark T, 12.4  
 Mende, Balazs, 13.17  
 Mennitto, Kristi, 53.9  
 Merchant, Courtney, 48[10:45]  
 Meredith, Stephanie L, 33.41  
 Merker, Stefan, 36[1:30]  
 Merritt, Catherine E, 24[11:15]  
 Merriwether, D. Andrew, 2[11:45], 13.3, 13.15, 18[2:30]  
 Mertz, Emily M, 52.5  
 Messer, Diana L, 53.7  
 Metzger, Marc, 34.18  
 Meyer, Jerrold S, 12.4  
 Meyer, Marc R, 30.1  
 Meyer, Valentine, 17[2:45]  
 Michalik, David, 20.6  
 Middleton, Emily R, 34.30  
 Mihailović, Bojana, 22[9:30]  
 Mihailović, Dušan, 22[9:30]  
 Milich, Krista M, 4[11:30]  
 Miller, Aaron A, 37[2:45]  
 Miller, Daniel J, 8.16  
 Miller, Ellen R, 42.2  
 Miller, Heidi, 9.32  
 Miller, Jordan A, 26[9:15]  
 Miller, Michael, 31.17  
 Miller, Rose, 52.3  
 Miller, Ryan, 51.5  
 Miller, Webb, 25[8:45]  
 Millette, James P, 11.22  
 Milner, George R, 6[Discussant], 53.2  
 Minsky-Rowland, Jocelyn D, 9.28  
 Minwer-Barakat, Raef, 8.1  
 Miranker, Molly, 9.17  
 Miro Herrans, Aida T, 5.14, 13.6  
 Miszkiewicz, Justyna J, 14.12, 32.11  
 Mitani, John C, 4[9:45], 26[9:30]  
 Mitchell, Patricia, 11.35  
 Mitra-Setia, Tatang, 45[9:30]  
 Miyamoto, Michael, 20.6, 20.7  
 Mjungu, Deus C, 7.4  
 Modry, David, 2[10:15]  
 Moffett, Elizabeth A, 23[10:15]  
 Moghaddam, Negahnaz, 54.13  
 Mohlke, Karen, 27.17  
 Mohseni, B. Tanya, 34.24  
 Moldawer, Alysse M, 1[10:45]  
 Moloney, Norah, 22[10:30]  
 Moloughney, Vincent, 53.32  
 Monckton, Spencer K, 45[8:15]  
 Monde, Sama S, 52.37  
 Monge, Janet M, 9.24, 20.6  
 Montgle, Carrie S, 30.10  
 Montague, Michael J, 2[9:30]  
 Montalva, Nicolas, 13.11, 13.12, 37[3:00]  
 Mooers, Arne, 30.16  
 Moore, Carla, 29.5  
 Moore, Joshua W R, 52.28  
 Moore, Megan K, 54.6, 55.17  
 Moore, Sophie E, 54.8  
 Moraga, Mauricio, 13.12  
 Morello, Flavia, 55.24  
 Moreno, Benjamin, 20.5  
 Morgan, David B, 2[9:15], 4[8:15], 26[9:00], 33.9  
 Moritz, Gillian L, 45[11:00]  
 Morris, Jessica M, 50.2  
 Morse, Paul E, 8.4  
 Moscovice, Liza R, 29.7  
 Mosher, Mj, 27.5, 27.6  
 Moyà-Solà, Salvador, 8.1, 8.39  
 Moyer, Eric, 23[9:30]  
 Muccigrosso, John D, 10.7  
 Muchlinski, Magdalena N, 31.17, 36[3:15]  
 Mudakikwa, Antoine, 11.26, 31.42  
 Muehlenbein, Michael P, 1[11:15], 26[10:30], 60[4:00]  
 Muldoon, Kathleen M, 25[8:45], 42[Chair], 42.9, 52.38  
 Mulhern, Dawn, 32.2  
 Müller, Felix, 54.13  
 Muller, Jennifer L, 41[Chair], 41.5  
 Muller, Martin, 1[10:30], 4[11:15], 7.4, 60[2:45, 3:15]  
 Mulligan, Connie J, 34.4, 44[Discussant], 9:00, 9:15]  
 Mundy, Nicholas I, 52.33  
 Muñoz, Ester, 13.5  
 Muñoz, María de L, 27.3  
 Murach, Michelle, 32.16  
 Murphy, Amanda L, 21.1  
 Murray, Carson M, 26[9:15, 11:30], 29.9  
 Murray, John, 22[10:30]  
 Musgrave, Stephanie, 33.9  
 Musiba, Charles M, 8.22  
 Musy, Marco, 34.3  
 Muzik, Otto, 1[9:00]  
 Muzzall, Evan, 31.37  
 Mychajliw, Alexis M, 5.4  
 Myers, Marcie J, 35.12  
 Myers, Monica S, 4[8:45]
- N**  
 Nachman, Brett, 8.17, 42.5  
 Nagy, Melinda, 13.17  
 Nalley, Tierra K, 30.2, 36[3:30]  
 Narula, Jagat, 20.6, 20.7  
 Nash, Lenina M, 6.4, 6.7  
 Natale, Gianfranco, 59[3:30]  
 Navega, David, 10.17  
 Nawrocki, Stephen P, 28.11  
 Ndagijimana, Felix, 12.6  
 Nekaris, K. A-I, 33.43, 42.12  
 Nelson, Andrew, 59[3:30]  
 Nelson, Elizabeth A, 28.14  
 Nelson, Greg C, 13.13  
 Nelson, Karen E, 2[10:15], 52.30  
 Nelson, Robin G, 58[Chair, 3:45]  
 Nengo, Isaiah O, 8.32, 25[11:45], 42.2  
 Nenko, Ilona, 58[2:30]  
 Nesbitt, Allison, 30.10, 32.34  
 Nesse, Hans P, 11.5  
 Neu, Ryan, 31.23  
 Ni, Xijun, 19.1  
 Nicholas, Christina L, 55.12  
 Nicklisch, Nicole, 5.10  
 Niedbalski, Sara D, 18[2:15], 44[8:15]  
 Nielsen, Rasmus, 5[8:40]  
 Nieves-Colon, Maria A, 13.8  
 Niinimäki, Sirpa TJ, 19.18  
 Nikolskiy, Pavel A, 13.3  
 Nishikawa, Mari, 52.18  
 Nishimura, Takeshi, 31.41  
 Niskanen, Markku, 19[Chair], 19.12, 19.14, 19.18  
 Njau, Jackson K, 49.2  
 Nkoranigwa, Mary, 33.20  
 Noble, Benjamin A, 52.36  
 Noche-Dowdy, Liotta, 10.30  
 Nockerts, Rebecca S, 52.13  
 Non, Amy L, 13.2, 34.5, 44[Chair, 8:30, 10:15]  
 Nora, Fernanda Grazielle da Silva Azevedo, 34.28  
 Norconk, Marilyn A, 52.28  
 Nordenfeldt, Suzanne, 5.10, 18[2:00]  
 North, Kari E, 27.14, 27.15, 27.17  
 Norton, Heather L, 5.8  
 Novak, Mario, 14.14  
 Novak, Melinda A, 12.4  
 Nowak, Natalia, 34.26, 47[8:30, 8:45]  
 Nunez, Chase L, 12.3  
 Nunn, Charles, 33.39  
 Nured-din, Abd el-Halim, 20.6  
 Nyárádi, Zsolt, 11.34  
 Nystrom, Kenneth C, 28.9  
 Nystrom, Pia, 14.12, 38[2:45]
- O**  
 Oakley, Elizabeth R, 59[4:00]  
 Ocobock, Cara J, 35.13  
 O'Connell, Caitlin A, 4[8:30]  
 O'Connell, James, 37[3:30]  
 O'Connor, Patrick M, 42.3  
 O'Donnell, Alexis, 48[11:30]  
 Oehrstroem, Lena, 53.11  
 Offenbecker, Adrienne M, 10.6  
 O'Hara, Mackie, 11.17  
 Ohman, James C, 30.19, 55.9, 55.11  
 Oishi, Motoharu, 31.16  
 Ojiambo, Robert, 17[3:30]  
 Oka, Ngakan P, 52.25  
 Oka, Rahul C, 15[3:00]  
 O'Keefe, Tadhg, 14.14

- Okutoyi, Paul, 17[3:30]  
 Olah, Angela, 8.28, 30.27  
 Olakkengil, Nicole P, 8.37  
 Olsen, Jesper, 37[3:00]  
 Olson, Sarah H, 2[9:15]  
 O'Mahoney, Thomas, 19.3, 32.13  
 O'Malley, Robert C, 26[11:30]  
 Ondzie, Alain, 2[9:15]  
 O'Neill, Kelsey D, 30.12, 50.15  
 O'Neill, Matthew C, 16[2:15], 23[9:30, 11:30, 11:45]  
 Onononga, Jean Robert, 26[9:00]  
 Organ, Jason M, 31.17, 36[3:30]  
 O'Rourke, Dennis H, 13.13, 27[Chair], 27.4  
 Orr, Caley M, 30.22  
 Ortega, Rebecca R, 27.20  
 Ortiz, Alejandra, 8.40  
 Ortiz, Kathryn M, 4[10:30]  
 Osborne, Daniel L, 55.15  
 Ossi-Lupo, Kerry, 60[3:30]  
 Ostendorf Smith, Maria, 11.32  
 Ostrander, Elaine A, 27.16  
 Ostrofsky, Kelly, 30.24, 39[1:30]  
 Otárola-Castillo, Erik, 17[3:30], 51.3, 60[3:15]  
 Ouattara, Karim, 52.34  
 Ousley, Stephen D, 9.16, 11.30, 40.5, 40.12, 55.10  
 Overholtzer, Lisa, 13.9  
 Owings, Amanda C, 13.10  
 Owsley, Douglas W, 9.10, 48[11:45]  
 Ozga, Andrew, 13.8
- P**  
 Pablos, Adrián, 43[10:15]  
 Pacheco, Jennifer, 44[11:30]  
 Pacheco, Victor R, 2[8:00]  
 Pacheco-Forés, Sofía I, 11.13  
 Pack, Frankie L, 5.2, 9.13, 28.15, 40.4  
 Padgett, Brian D, 10.4  
 Padilla, Eva A, 34.1  
 Page, Katherine E, 14.3  
 Pages, Guillaume, 26[11:00]  
 Paine, Oliver, 33.18  
 Paine, Robert R, 10.18, 10.19, 10.26, 10.28, 14.6, 53.29  
 Pak, Sunyoung, 10.24, 53.3  
 Palkopoulou, Eleftheria, 2[11:30]  
 Pampush, James D, 11.14, 11.15, 31.8, 32.32  
 Pan, Tiffany D, 50.4  
 Pandrea, Ivona, 26[10:15]  
 Pantoja-pérez, Ana, 43[8:15]  
 Papageorgopoulou, Christina, 18[2:45]  
 Papathanasiou, Anastasia, 24[8:15]  
 Pappano, David J, 26[8:30]  
 Parga, Joyce A, 33.40  
 Parker, Kathryn A, 9.34  
 Parker, Patricia G, 54.1  
 Parks, Connie, 53.16  
 Parra, Esteban J, 5.8  
 Pasko, D, 27.17  
 Passalacqua, Nicholas V, 9.25, 40.3  
 Pate, Donald, 34.14  
 Patel, Biren A, 8.32, 30.22, 30.23, 39[2:45]  
 Pathak, Rahul, 8.16  
 Patiño, May, 52.20  
 Patterson, Nick, 5.10, 18[2:00]  
 Patterson, Samantha K, 26[8:00]  
 Paul, Kathleen S, 11.4, 11.5, 48[11:00]  
 Pavlova, Elena Yu, 13.3  
 Peacock, Julie, 41.11  
 Pearman, Tessa L, 31.14  
 Pearson, Laurel N, 44[9:15]  
 Pearson, Meghan, 33.33  
 Pearson, Osbjorn M, 32[Chair], 32.15  
 Peart, Daniel C, 30.25  
 Peate, David W, 9.31  
 Pedersen, Rebecca L, 35.5  
 Peeters, Martine, 2[9:15]  
 Peischl, Stephan, 18[1:00]  
 Pélissier, Amélie, 11.28  
 Pellatier, Natalie A, 59[2:45]  
 Pemberton, Trevor J, 5[9:20], 5.6  
 Peña, Luis, 14.9  
 Peppe, Daniel J, 25[11:45], 39[2:30]  
 Perash, Rachel M, 11.27  
 Perchalski, Bernadette, 17[2:15], 32.9, 38[2:00]  
 Percival, Christopher J, 57[3:45]  
 Pereira, Luiz CM, 2[10:30]  
 Pérez, Ventura R, 52.1  
 Pérez-ramírez, Gerardo, 27.3  
 Perlman, Rachel F, 33.27  
 Perrone, Alexandra, 3[10:45]  
 Perry, George H, 25[8:45], 30.30  
 Perry, Jonathan MG, 8.2, 19.2, 31.30  
 Perry, Megan A, 9.34, 14.4  
 Peschel, Emily M, 59[2:30]  
 Pestle, William J, 10.8, 13.8  
 Petersdorf, Megan, 31.35  
 Peterson, Faina, 34.35  
 Peterson, Jeffrey V, 52.25  
 Petraglia, Michael, 22[8:30]  
 Petruccio, Lauren A, 33.24  
 Petzelkova, Klara, 2[10:15]  
 Pfälzner, Peter, 9.42  
 Pfeleiderer, Silvia, 25[9:00]  
 Pharr, Lauren R, 53.24  
 Phelippeau, Harold, 11.28  
 Phillips, Kimberley, 1[9:45]  
 Phillips-Krawczak, Christine, 27.2  
 Phippen, Colton M, 32.5  
 Pickrell, Joseph, 5.10  
 Pike, Alistair, 55.22  
 Pilbro, Clayton D, 56[Chair], 56.7  
 Pilbrow, Varsha, 8.36, 8.40, 9.3, 11.3, 24[10:45]  
 Pilloud, Marin A, 40[Chair], 40.1, 40.9  
 Pina, Marta, 8.39  
 Pinhasi, Ron, 13.16, 40.14, 40.15, 55.1  
 Pinilla, José, 9.12  
 Pink, Christine M, 40.7  
 Pitre, Mindy C, 50.7  
 Pitsiladis, Yannis, 17[3:30]  
 Pittman, Chris, 51.5  
 Pitulko, Vladimir V, 13.3  
 Pizarro, Mark, 52.17  
 Placke, Arielle, 38[2:00]  
 Planz, John V, 28.14  
 Plavcan, J. Michael, 16[Chair, 1:15], 39[2:45]  
 Plomp, Kimberly A, 17[1:15]  
 Plummer, Thomas W, 39[2:30]  
 Pobiner, Briana, 51.6  
 Podini, Daniele, 27.7  
 Poinar, Hendrik N, 21.7  
 Pokines, James T, 53.6  
 Polcyn, Marek, 9.29, 59[3:15]  
 Policeni, Bruno, 55.12  
 Polk, John D, 34.2, 57[2:45]  
 Polonitza, Austin L, 55.25  
 Ponce de León, Marcia S, 1[8:30], 15[2:15]  
 Ponche, Jean-Luc, 22[11:15]  
 Pontzer, Herman, 1[Chair, 8:45, 11:30], 17[1:00], 31.27, 60[3:15]  
 Poole, K., 19.16  
 Porter, Leila M, 33.7, 33.37  
 Potau, Josep, 4[8:00]  
 Potts, Richard, 39[2:30]  
 Potze, Stephany, 30.27  
 Powell, Ellen E, 12.12, 31.30  
 Powell, John W, 10.30  
 Powell, Vance C R, 32.24  
 Poza-Rey, Eva-María, 43[8:30]  
 Prall, Sean P, 26[10:30], 60[4:00]  
 Prentice, Andrew M, 54.8  
 Prior, Fred W, 39[3:30]  
 Proctor, Lindsey G, 9.24  
 Province, Michael, 13.23  
 Prowse, Tracy, 21.7  
 Pruetz, Jill, 26[9:30], 51.9, 52.35  
 Prufrock, Kristen A, 8.12  
 Pryor, Nathaniel P, 33.32  
 Pryor Smith, Leslie C, 30.7, 30.8  
 Pugh, Kelsey D, 8.24, 8.25  
 Puppala, Sobha, 27.10  
 Püschel, Thomas A, 31.9  
 Pusey, Anne E, 4[9:30], 7.4, 26[9:15, 11:30], 29.9
- Q**  
 Quam, Rolf M, 43[Chair, 10:45]  
 Quellette, Quinton L, 34.7  
 Quereshi, Ford, 53.5  
 Quillen, Ellen E, 44[10:30]  
 Quinn, E A, 15[3:15]  
 Quinn, Rhonda L, 55.20  
 Quintyn, Conrad B, 38[2:30]
- R**  
 Raam, Ryan L, 9.11  
 Rabetoandro, Nandrianina, 52.4  
 Rabey, Karyne N, 17[3:00], 23[10:30]  
 Rae, Todd C, 23[Chair, 9:00], 25[9:00]  
 Raff, Jennifer A, 5.14, 13.6, 27.4  
 Raghanti, Mary Ann, 31.29  
 Ragsdale, Corey S, 9.30  
 Raguet-Schofield, Melissa, 52.30  
 Raguin, Émeline, 32.10, 32.18  
 Raharison, Fanomezantsoa Jean-Luc, 52.4  
 Raichlen, David A, 17[2:15], 32.9, 32.28, 38[2:00]  
 Rainbow, Michael J, 17[3:45]  
 Raines, Jennifer L, 14.17  
 Rak, Yoel, 16[1:45], 43[8:45]  
 Rakotondramavo, Jean Claude, 42.4  
 Ramachandran, Sohini, 5[9:20]  
 Ramirez, Kristen R, 31.27  
 Ramos Magalhaes, José, 11.28  
 Ramos, Eduardo, 27.3  
 Ramsier, Marissa, 9.29, 52.20  
 Randriamasy, Tsiorintsoa, 52.4  
 Ranivoharimanana, Lovasoa, 42.4  
 Rasmussen, David T, 60[2:15]  
 Rasolondravoavy, Charles, 52.6  
 Rasse, Michel, 22[8:00]

- Rasskazova, Anna V, 3[11:15]  
 Ratliff, Melody D, 53.12  
 Raubenheimer, David, 1[10:45]  
 Rautman, Anna L.M, 34.21  
 Ravosa, Matthew J, 23[8:45, 9:15], 31.4, 31.38  
 Ray, Diego, 13.5  
 Reagan, Natalia A, 51.11  
 Rector, Amy L, 16[1:00], 30.12, 50.15  
 Reddy, Rachna B, 33.42  
 Reece, Sandra P, 33.11  
 Reed, Denne, 51.5  
 Reed, Patricia, 2[9:15]  
 Reedy, Sarah, 55.8  
 Reeves, Jonathan, 39[1:30]  
 Regan, Laura A, 53.21  
 Regassa, Teshome, 54.3  
 Regueiro, Manuela, 18[1:30]  
 Reich, Carina, 9.14  
 Reich, David, 2[11:30], 5.10, 18[2:00]  
 Reiches, Meredith W, 54.8  
 Reid, Donald J, 11.26  
 Reid, Meredith L, 58[4:15]  
 Rein, Thomas R, 31.6  
 Reinberger, Katherine L, 54.12  
 Reiner, Whitney B, 39[3:00], 49.2  
 Reints, Rebecca G, 33.28  
 Reiser, Peter J, 23[9:30]  
 Reitsema, Laurie J, 3[Chair, 10:30], 55.13  
 Rej, Peter H, 34.4  
 Relethford, John H, 27[Discussant], 40.2  
 Remy, Ashley J, 14.12, 30.13  
 Renner, Elizabeth R, 33.1  
 Rennie, Samuel R, 30.19  
 Reusch, Kathryn, 21.6  
 Reyes, Laura D, 57[4:30]  
 Reynard, Linda M, 24[8:30]  
 Reyzer, Michelle L, 1[9:15]  
 Rhodes, Jill A, 10.7  
 Richard, Adam, 53.16  
 Richards, Gary D, 32.33, 55.4  
 Richards, Michael P, 24[8:45]  
 Richardson, Brian C, 18[1:30]  
 Richardson, Simon, 49.1  
 Richmond, Brian G, 17[3:45], 19[Discussant], 30.7, 30.8, 30.24, 39[1:15, 1:30, 2:00]  
 Richtsmeier, Joan T, 2[9:00], 34.3, 39[3:30]  
 Righini, Nicoletta, 52.30  
 Riley, Crystal M, 33.19, 52.23  
 Riley, Erin P, 52.25  
 Riordan, Quincy M, 34.20  
 Risser, Daniele U, 55.6  
 Risy, Ronald, 55.6  
 Ritzman, Terrence, 16[3:15], 35.6, 57[3:45]  
 Rivara, Anna, 10.30  
 Roach, Neil T, 17[3:45], 30.18, 39[1:30]  
 Robakis, Efstathia E, 33.31  
 Roberts, Charlotte A, 20[Chair], 20.1, 20.2, 20.4  
 Roberts, Eric M, 42.3  
 Robertson, Suloni, 51.5  
 Robinson, Chris A, 16[3:15], 30.4, 35.6  
 Robl, Nick J, 31.39  
 Robson Brown, Kate A, 48[10:30], 55.7  
 Rockwell, L. Christie, 12.1  
 Rodney, Nicole C, 34.4  
 Rodrigues, Michelle A, 29[Chair], 29.1, 50.12  
 Rodriguez, Laura, 19.8, 43[9:45, 10:30]  
 Rodriguez, Lizette, 14.6  
 Rodríguez-Alegría, Enrique, 13.9  
 Rogers, Jeffrey, 2[9:00], 52.26  
 Rogers, Mary P, 13.10, 34.2, 34.10  
 Rogers, Michael A, 35.10  
 Rohland, Nadin, 5.10, 18[2:00]  
 Roksandic, Mirjana, 22[9:30]  
 Rolian, Campbell, 23[11:00], 31.28  
 Rolland, Matthew D, 53.25, 53.31  
 Romano-pacheco, Arturo, 27.3  
 Rosas, Antonio, 22[10:30]  
 Rosati, Alexandra G, 26[10:45]  
 Rose, Kenneth D, 8.7  
 Roseman, Charles C, 5.3, 5.7, 34.31, 57[2:45]  
 Rosen, Jeremiah, 4[11:15]  
 Rosenbaum, Stacy, 4[11:45]  
 Rosenberg, Karen R, 15[Chair, 1:00, 1:15]  
 Rosenberg, Kendra, 12.4  
 Rosenberg, Noah A, 5[9:20], 5.6, 44[11:15]  
 Rosenberger, Alfred L, 8.9, 36[Chair, 2:45]  
 Rosenfield, Kevin A, 4[11:30]  
 Ross, Ann H, 5.11, 19.15  
 Ross, Callum F, 11.21, 23[8:15], 30.7, 30.8, 31.36  
 Ross, Caroline, 33.15  
 Ross, Stephen R, 1[8:45]  
 Rossie, James B, 25[11:15]  
 Rothman, Jessica M, 1[10:45], 2[10:15], 4[8:45, 9:00], 12.14  
 Rothwell, Jessica E, 11.34  
 Rottier, Stéphane, 24[8:00]  
 Rotundo, Marcelo, 12.13  
 Roulette, Casey J, 54.2  
 Rouse, Stephen L, 9.10  
 Rubicz, Rohina, 27.16  
 Rudicell, Rebecca S, 4[9:30]  
 Rue, Megan J, 34.34  
 Ruff, Christopher B, 8.39, 19[Chair], 19.2, 19.5, 19.7, 19.9, 19.12, 19.14  
 Ruhlen, Merritt, 5[9:20]  
 Rühli, Frank, 13.4, 34.33, 37[3:00], 53[Chair], 53.5, 53.11  
 Ruiz-Lopez, Maria J, 52.21  
 Ruiz-miranda, Carlos R, 2[10:30], 52.29  
 Runestad Connour, Jacqueline A, 19.2, 31.18  
 Russell, Andrew F, 7.8  
 Ruth, Aidan A, 31.29  
 Rutherford, Julienne N, 1[9:45], 15[2:00]  
 Ruvolo, Maryellen, 18[3:00]  
 Ryan, Timothy M, 17[2:15], 32.7, 32.9, 38[2:00], 55.14  
 Rye, Philip, 22[10:30]  
 Rzhetskaya, Margarita, 5.14, 27.4
- S**  
 Saavedra, Fernando M, 13.14  
 Sabeti, Pardis C, 18[3:00]  
 Sagona, Antonio, 24[10:45]  
 Saire, Claudia L, 33.37  
 Sala, Nohemi, 43[8:00]  
 Saleem, Sahar, 59[3:30]  
 Salmi, Roberta, 33.2  
 Saltonstall, Kristin, 52.33  
 Samms, Krystin M, 13.9  
 Samonds, Karen E, 8.5  
 Sams, Aaron J, 18[1:15]  
 Samson, David, 33.39  
 Sancilio, Amelia E, 34.9, 37[3:45]  
 Sandberg, Paul A, 10.20  
 Sanders, Akiva, 18[1:45]  
 Sandhu, Kayleigh A, 10.14  
 Sandoval, Vanessa, 33.35  
 Sanford, Summer R, 33.6  
 Sang, Meshak, 17[3:30]  
 Santana, Francisca A, 3[8:45]  
 Santillan, Donna A, 27.8  
 Santillan, Mark K, 27.8  
 Santos, Isabel T, 54.5  
 Santos, Laurie R, 26[10:45]  
 Sanz, Crickette, 2[9:15], 4[8:15], 26[9:00], 33.9  
 Sargis, Eric J, 8.8  
 Sarig, Rachel, 35.4  
 Sato, Akiko, 4[11:00]  
 Sattenspiel, Lisa, 24[9:45]  
 Sattler, Robert, 55.19  
 Sauther, Michelle L, 11.22, 52.8, 52.10  
 Savell, Kristen R. R, 34.31  
 Savini, Tommaso, 52.31  
 Sawyer, Gary J, 30.1  
 Sayavongkhamdy, Thongsa, 22[11:15]  
 Scarry, Clara J, 4[10:45], 33.29  
 Schaefer, Melissa S, 50.9  
 Schanfield, M.s., 27.6  
 Schanfield, Moses S, 27.7  
 Schaye, Michala KS, 53.4  
 Scheidel, Caleb, 33.33  
 Scherf, Heike, 10.16  
 Schilder, Brian M, 34.17  
 Schillaci, Michael A, 21.8  
 Schlager, Stefan, 34.18, 53.18  
 Schlecht, Stephen H, 32.11, 32.16  
 Schmid, Peter, 30.14  
 Schmidt, Christopher W, 10.3, 14.12, 30.13, 59[4:00]  
 Schmitt, Christopher A, 2[9:45], 33.34  
 Schmitt, Daniel, 23[9:45, 10:30], 31.15  
 Schnellberger, Jack B, 10.3  
 Schoenemann, P. Thomas, 46[11:15, 11:30, 11:45]  
 Schoeninger, Margaret J, 16[1:30], 57[4:45]  
 Schomberg, Roman, 40.8  
 Schoof, Valerie AM, 12[Chair], 12.14  
 Schotten, Kaylee L, 14.2  
 Schreier, Amy L, 33.28, 33.32  
 Schrein, Caitlin M, 51[Chair, Discussant], 51.1  
 Schrenk, Friedemann, 1[8:15], 22[8:15]  
 Schroeder, Lauren, 39[1:00]  
 Schroepfer-Walker, Kara, 29.9  
 Schroer, Kes, 35.16  
 Schrueth, David M, 52.12  
 Schultz, John J, 14.2, 14.3  
 Schumann, Cynthia M, 34.15  
 Schurr, Mark R, 52.17  
 Schurr, Theodore G, 18[Chair, 1:45]  
 Schuster, Stephan, 25[8:45]  
 Schutkowski, Holger, 14.13, 24[Chair, 9:30]  
 Schwarcz, Henry P, 48[11:45]  
 Schwartz, Gary T, 1[8:00], 11.11  
 Schwartz, Jay W, 26[8:45]  
 Schwartz, Marion, 12.2  
 Schwarz, Laura, 10.27  
 Sciuilli, Paul W, 10.11  
 Scollan, Joseph P, 23[8:45]  
 Scott, Amy B, 59[3:15]  
 Scott, G. Richard, 40.8, 40.9



## Author/Session Index

62

- Scott, Jeremiah E, 11.18, 23[8:45]  
 Scott, Jill E, 39[3:15]  
 Scott, Robert S, 23[8:30], 27.17, 35.10  
 Sefczek, Timothy M, 11.35  
 Seguchi, Noriko, 9.39, 38[2:30]  
 Seidemann, Ryan M, 11.33  
 Seiffert, Erik R, 42.3  
 Seitelman, Brielle C, 8.19, 57[4:00]  
 Selby, Michael S, 31.5  
 Sellers, William I, 19.3, 23[10:45], 31.9, 32.13  
 Semendeferi, Katerina, 15[2:30]  
 Service, Susan K, 2[9:45]  
 Šešelj, Maja, 35.7  
 Seyfarth, Robert M, 26[8:00]  
 Seyoum, Chalachew M, 12.15  
 Shackelford, Laura L, 22[11:15], 35.11  
 Shaffer, Christopher A, 45[Chair, 8:30]  
 Shamoon-pour, Michel, 18[2:30]  
 Shapiro, Amy E, 25[11:00]  
 Shapiro, Darshana, 31.3  
 Shariff, Faisal S, 23[8:45]  
 Sharpe, James, 34.3  
 Shattuck-Heidorn, Heather, 54.8  
 Shaw, Colin N, 9.5, 19.16, 32.14, 38[2:00]  
 Shaw, Eric, 52.17  
 Shaw, Heidi A, 59[2:00, 3:00]  
 Shea, Emily A, 24[9:00]  
 Shearer, Brian M, 8.15, 8.20  
 Sheil, Douglas, 45[10:30]  
 Shekelle, Myron, 36[1:30], 42.11  
 Shelley, Matthew F, 34.15  
 Shengelia, Ramaz, 18[1:45]  
 Sherwood, Chet C, 1[9:00, 9:15], 33.8, 34.17, 57[4:30]  
 Sherwood, Kate D, 9.10  
 Shidlovskiy, Fedor K, 13.3  
 Shirasu, Mika, 4[8:45]  
 Shirley, Natalie R, 9.16  
 Sholts, Sabrina B, 48[10:15]  
 Short, Nicholas A, 54.4  
 Shriver, Mark D, 44[10:30]  
 Shui, Irene M, 27.16  
 Shuttleworth, Russell, 41[Discussant]  
 Sicotte, Pascale, 33.26, 60[2:30]  
 Siegel, Jerome, 58[4:00]  
 Siegel, Nicole D, 31.38  
 Sierp, Ingrid M, 53.17  
 Sigei, Timothy, 17[3:30]  
 Silcox, Mary T, 8[Chair], 8.6, 8.7, 8.12, 8.13  
 Silk, Joan B, 4[11:45]  
 Silva Gallardo, Constanza P, 13.22  
 Silva, Hilton P, 49.5  
 Silva, Ita O, 2[10:30]  
 Simmons, Nicole, 26[9:30]  
 Simons, Evan A, 31.31, 31.32, 31.33  
 Simons, Mirre JP, 58[2:30]  
 Simons, Noah D, 52.21  
 Singleton, Michelle, 8.19  
 Sirak, Kendra A, 13.16, 54.11  
 Sirianni, Joyce E, 11.36, 14.17  
 Skedros, John G, 32.5, 55.23  
 Skoglund, Pontus, 2[11:30], 18[2:00]  
 Skrinyer, Andrew, 50.2  
 Sládek, Vladimír, 9.8, 19.12, 19.14, 31.12, 35.14, 55.16  
 Slater, Philip A, 6.2, 52.38  
 Slavín, Philip, 14.12  
 Slice, Dennis E, 30.7, 30.8  
 Smaers, Jeroen B, 25[8:30]  
 Smail, Irene E, 8.27  
 Smith, Amanda L, 30.7, 30.8  
 Smith, April K, 55.13  
 Smith, Gregory A, 31.11  
 Smith, Heather F, 40.4  
 Smith, Kirk E, 39[3:30]  
 Smith, Lindsey W, 33.4  
 Smith, Maria O, 10.21, 11.37  
 Smith, Mike, 30.1  
 Smith, Richard, 36[2:00]  
 Smith, Sharia, 9.14  
 Smith, Tanya M, 30.29, 38[Chair, 1:15]  
 Smith, Thierry, 19.1, 36[2:00]  
 Smith, Timothy D, 12.12, 36[Chair, 2:45, 3:15]  
 Snodgrass, J Josh, 26[9:45], 27.18, 34.23, 34.32, 58[2:00, 2:15]  
 Snowden, Brenda, 9.27  
 Snowden, Kelly A, 31.17  
 Snyder, Michael, 18[1:00]  
 Snyder-Mackler, Noah, 29.4, 29.5  
 Sofer, Joanna R, 41.4  
 Solé-Morata, Neus, 18[3:15]  
 Soligo, Christophe, 8.11  
 Soliman, Muhammad Al-Tohamy, 20.6  
 Somerville, Andrew D, 57[4:45]  
 Sone, Yoshiaki, 34.22  
 Songita, Augusto, 39[3:00]  
 Soriano, Sylvain, 22[8:00]  
 Southam, L, 27.17  
 Southard, Thomas E, 32.31  
 Southwell-Wright, William A, 41.1  
 Sparacello, Vitale S, 9.5, 9.23, 32.15  
 Sparrey, Carolyn J, 32.27  
 Sparrow, Leah, 23[11:00]  
 Speller, Camilla, 37[3:00]  
 Spence, Donica, 33.3, 33.13  
 Spencer, Mark A, 30.7, 30.8  
 Spencer, Susan D, 6.8, 53.15  
 Spiewak, Ted A, 57[4:00]  
 Spillman, Brigitte, 45[9:30]  
 Sponheimer, Matt, 33.18  
 Spradley, Jackson P, 25[10:15]  
 Spradley, M. Katherine, 40.11  
 Sprague, David S, 52.18  
 Spriggs, Amanda N, 33.38  
 Squires, Erica, 26[9:45]  
 Squyres, Nicole, 19.9  
 Sridhar, Shilpa, 19.6  
 Srikantan, Jayasri, 52.23  
 Staedele, Veronika, 33.16  
 Stafford, Jr., Thomas, 48[11:45]  
 Stanford, Janet L, 27.16  
 Stantis, Christina, 24[8:45]  
 Stanton, Margaret A, 26[9:15, 11:30]  
 Staub, Kaspar, 34.33, 53.11  
 St. Clair, Elizabeth M, 8.2, 11.23  
 Steadman, Dawnie W, 28.15  
 Stefanović, Sofija, 24[8:00]  
 Stefański, Damian, 35.18  
 Steinmetz, Joan, 50.14  
 Stern Jr., Jack T, 23[11:15]  
 Sterner, Kirstin N, 52.21  
 Studel-Numbers, Karen L, 35.12  
 Stevens, Jeroen M.G, 60[4:15]  
 Stevens, Nancy J, 25[11:45], 42.3  
 Stevenson, Joan C, 27.20  
 Stewardson, Kristin, 5.10  
 Stewart, Alexandre F, 20.7  
 Stewart, Marissa C, 53.14  
 Stieglitz, Jonathan, 1[11:30], 7.9, 37[2:30]  
 Stimpson, Cheryl D, 33.8  
 Stock, Jay T, 19.16, 55.1  
 Stodder, Ann L.W, 41.6  
 Stoinski, Tara S, 4[11:45], 11.26, 12.6, 31.42  
 Stojanowski, Christopher M, 48[11:00]  
 Stone, Anne C, 2[10:30, 11:15], 13.8, 52.19, 52.29  
 Stone, Jessica H, 13.13  
 Stout, Samuel D, 55.21  
 Strait, David S, 30.7, 30.8, 35.15  
 Strait, Suzanne G, 8.4  
 Strand, Ryan, 37[1:45]  
 Strandburg-Peshkin, Ariana, 7.1  
 Strand Vidarsdottir, Una, 17[1:15]  
 Strauss, André, 9.1  
 Streeter, Margaret A, 32.10, 32.18  
 Strier, Karen B, 52.9  
 Strindberg, Samantha, 26[9:00]  
 Stull, Kyra E, 19.4, 34[Chair], 34.13  
 Stumpf, Rebecca M, 2[10:15], 33.6, 52.30  
 Styler, Sarah A, 45[8:15]  
 Su, Anne, 30.20  
 Su, Denise F, 31.13  
 Subiaul, Francys, 33.1  
 Sugiyama, Lawrence S, 49.4, 58[2:00, 2:15]  
 Sukhdeo, Simone M, 17[2:15], 32.7, 32.9, 38[2:00]  
 Sullivan, Lynne P, 41.9  
 Sullivan, Walter M, 10.14  
 Sumner, Bonnie J, 23[11:15]  
 Sun, Zhichao, 53.19, 54.7  
 Suomi, Stephen J, 12.4  
 Susman, Randall L, 30.23  
 Sutherland, James D, 20.6, 20.7  
 Sutherland, M Linda, 20.6, 20.7  
 Sutherland, Michael R, 8.5  
 Swallow, Dallas M, 37[3:00]  
 Swedell, Larissa, 29.2, 33.16  
 Swedlund, Alan C, 24[9:45]  
 Sweeney, Aileen P, 12.8  
 Sylvestre, Adam D, 16[2:00]  
 Syme, Kristen L, 54.9  
 Sztraicher, Delaney, 5.4  
 Szurek, Sarah M, 34.4, 44[9:00], 44[9:15]
- ## T
- Taboada, Hannah G, 30.15  
 Tabor, Neil J, 42.5  
 Tacey, Ivan, 37[1:30]  
 Tackney, Justin, 13.13, 27.4  
 Tadessa, Tsegaye, 54.3  
 Tafforeau, Paul, 30.29  
 Tagliatalata, Jared P, 33.8  
 Tague, Robert G, 32.29  
 Tallman, Melissa, 8.20, 30.27  
 Tallman, Sean D, 28.13  
 Tamayo, Marilyne, 37[2:00]  
 Tamvada, Kelli H, 30.7, 30.8, 35.15  
 Tang, Tuan, 51.5  
 Tantipisanuh, Naruemon, 52.31  
 Tapanes, Elizabeth, 33.36  
 Tappen, Martha, 52.13  
 Tarskaia, Larissa A, 27.18  
 Taylor, Andrea B, 11.21, 23[8:15], 31.36, 50.6  
 Taylor, John H, 20.5  
 Taylor, Linda, 12.16, 53.32

- Taysom, Ely, 34.13  
 Teaford, Mark F, 11.20, 11.21  
 Tecot, Stacey R, 12.11, 49.6, 60[3:45]  
 Teichroeb, Julie A, 12.14, 33.23  
 Temirbekov, Sayat, 22[10:45]  
 Temple, Daniel H, 48[10:45, 11:15]  
 TenBarge, Joseph, 51.5  
 Terhune, Claire E, 16[3:15], 23[8:15], 31.36, 35.6  
 Teti, Wirda, 33.43  
 Thayer, Zaneta M, 44[8:45]  
 Thetford, Maya n, 32.22  
 Thomas, David, 32.4  
 Thomas, Gregory S, 20.6, 20.7  
 Thomas, Jonathan T, 9.31  
 Thomas, Richard M, 53.16  
 Thomas, Wade, 9.33  
 Thompson, Andrew R, 28.2  
 Thompson, Cynthia L, 31.39, 33.33  
 Thompson, Melissa E, 7.3  
 Thompson, Nathan E, 16[2:15], 23[11:30, 11:45]  
 Thompson, Randall C, 20.6, 20.7  
 Throckmorton, Zach, 34.24  
 Thune, Inger, 58[3:00]  
 Timoshin, Valery B, 13.3  
 Ting, Nelson, 52.21  
 Tinsley Johnson, Elizabeth, 29.4  
 Tobin, Cole, 33.13  
 Tocheri, Matthew W, 30.22, 39[2:15]  
 Tod, Angelique, 2[10:15]  
 Todd, Lawrence C, 42.5  
 Tokuda, Isao T, 31.41  
 Tomasto, Elsa, 18[2:00]  
 Tonoike, Yukiko, 59[2:45]  
 Torres, Gabriel A, 44[8:00]  
 Torres-Rouff, Christina, 10.8, 24[11:00]  
 Tosi, Anthony J, 52.14, 52.24  
 Touhara, Kazushige, 4[8:45]  
 Tourloukis, Vangelis, 22[9:15, 9:45]  
 Townsend, K.e. Beth, 42.8  
 Trachsel, Christian, 37[3:00]  
 Tran, Cassandra, 8.32  
 Trask, Willa R, 53.21  
 Travis, Dominic, 26[9:30]  
 Tremblay, Anna, 9.19  
 Tremblay Critcher, Lori A, 14.16  
 Trevathan, Wenda R, 15[Chair, 1:00, 1:15]  
 Trexler, Kristen R, 33.22  
 Tribolo, Chantal, 22[8:00]  
 Trinkaus, Erik, 30.23, 43[Discussant]  
 Tripp, Cameron H, 23[9:45], 31.15  
 Trumble, Benjamin C, 1[11:30], 4[9:15], 37[2:30]  
 Tryon, Christian A, 39[2:30]  
 Tuamsuk, Panya, 34.13, 53.14  
 Tukhbatova, Rezeda I, 3[11:15]  
 Tüma, Jan, 31.12  
 Tung, Jenny, 29.5  
 Turcot, Valerie, 27.17  
 Turcotte, Cassandra M, 4[8:00]  
 Turner, Bethany L, 24[10:30, 11:45]  
 Turner, Elaine, 35.5  
 Turner, Trudy, 2[9:30]  
 Turner-Livermore, Bethany L, 14.8, 14.10  
 Tuross, Noreen, 24[8:30]  
 Twinomugisha, Dennis, 12.14  
 Tyler Faith, J., 39[2:30]
- U**  
 Uhl, Natalie M, 19.4  
 Ullinger, Jaime M, 9.13, 24[11:30]  
 Ullrich, Oliver, 53.5  
 Umana, Juan D, 2[10:15]  
 Umans, Jason G, 27.12  
 Umberger, Brian R, 16[2:15]  
 Underwood, Carol E, 31.24  
 Ungar, Peter S, 11.20  
 Unterländer, Martina, 18[2:45]  
 Urbas, Sarah, 35.3  
 Uribe, Gabriel, 18[1:30]  
 Uribe, Mauricio I, 3[8:45]  
 Urlacher, Samuel S, 58[2:00, 2:15]  
 Utami Atmoko, Sri Suci, 1[10:45]
- V**  
 Vakiener, Meagan M, 54.14  
 Valde-Nowak, Paweł, 35.18  
 Valeggia, Claudia, 34.9, 49.7, 58[3:15]  
 Valença-montenegro, Mônica M, 33.30  
 Valenta, Kim, 45[8:15]  
 Vallodolid, Clide M, 20.6  
 Van Arsdale, Adam, 22[10:45]  
 Van Belle, Sarie, 7.2  
 Van Cleave, Eric, 45[10:30]  
 Vandenbeusch, Marie, 20.5  
 Vandercone, Rajnish P, 42.10  
 Van der made, Jan, 22[10:30]  
 Vandever, Robert H, 13.9  
 Van Gerven, Dennis P, 9.43, 54.11  
 Van Horn, Andrew, 12.1  
 van Noordwijk, Maria A, 1[10:45], 45[9:30]  
 VanSickle, Caroline, 56.10  
 Varela-Silva, Maria Ines, 49.1  
 Vashro, Layne, 37[3:30]  
 Vayro, Josie V, 60[2:30]  
 Velissaris, Julian, 55.6  
 Velkey, J. Matthew, 50.6  
 Venkataraman, Vivek V, 4[8:45], 37[1:30]  
 Vercellotti, Giuseppe, 9.23  
 Verdu, Paul, 5.6  
 Verrelli, Brian C, 50.15  
 Viciano, Joan, 59[4:00]  
 Vieira, Marcus Fraga, 34.28  
 Vigilant, Linda, 2[9:15], 4[11:45], 33.16  
 Vilar, Miguel, 18[1:45]  
 Villafuerte, Maria J, 11.6  
 Villamil, Catalina I, 8.40, 30.9  
 Villaseñor, Amelia, 57[2:00]  
 Villmoare, Brian, 30.7, 30.18, 39[1:30]  
 Vinyard, Christopher J, 11.21, 31[Chair], 31.38, 31.39, 33.33  
 Viola, Bence, 22[10:15]  
 Virgin, Emily E, 33.37  
 Vlckova, Klara, 2[10:15]  
 Vo, Kevin T, 8.29  
 Vogel, Erin R, 1[10:45], 17[1:00], 23[8:30], 45[9:30]  
 Vololonoro, Holiarimino, 52.4  
 von Cramon-Taubadel, Noreen, 9.1  
 von Rueden, Chris R, 7[Chair], 7.9  
 Voruganti, V. Saroja, 27.12
- W**  
 Wade, Samantha A, 53.26  
 Wade, Andrew D, 59[3:30]
- Wagner, Jennifer K, 44[11:00]  
 Wahl, Joachim, 10.16  
 Wakefield, Monica L, 29[Chair], 29.8, 33.12  
 Wakita, Masumi, 31.41  
 Walker, Christopher S, 19.6  
 Walker, Robert A, 53.9  
 Walker-Bolton, Amber D, 33.40  
 Wall, Christine E, 32.19  
 Wallace, Ian J, 17[3:15], 39[2:45]  
 Wallduck, Rosalind, 56.1, 56.2  
 Waller, Kyle D, 9.9  
 Waller, Michel T, 49[Chair], 49.3  
 Wall-Scheffler, Cara M, 15[3:45], 34.7, 34.27, 35.5, 35.12  
 Walser III, Joe W, 20.3  
 Walshe, Keryn, 9.20, 32.12  
 Walsh-Haney, Heather A, 53.25, 53.26, 53.31, 55.25  
 Walter, Brittany S, 9.36  
 Walz, Jessica T, 29.3  
 Wang, Lihua, 13.23  
 Wang, Qian, 11.12, 30.7, 30.8  
 Wang, Wei, 22[11:00]  
 Wann, L. Samuel, 20.6, 20.7  
 Ward, Carol V, 16[1:15], 39[2:45]  
 Warinner, Christina, 13.8, 37[3:00]  
 Warner, Monica M, 53.21  
 Warren, Amy L, 24[9:45]  
 Warren, Kerryn A, 57[3:45]  
 Warren, Wesley C, 2[9:30]  
 Warren, Anna G, 17[2:00]  
 Wasserman, Michael D, 4[9:00]  
 Waterman, Anna J, 9.31  
 Watkins, Ronald T, 42.2  
 Watsa, Mrinalini, 52.29, 54.1, 60[2:15]  
 Watson, Luchia, 20.6, 20.7  
 Watts, David P, 4[9:45], 26[9:30]  
 Weaver, Hugh, 8.36  
 Weaver, Mariah, 52.2, 52.8  
 Weaver, Timothy D, 5.13  
 Weaver, Victoria R, 45[9:45]  
 Weber, Gerhard W, 30.7, 30.8, 35.4  
 Webster, Timothy H, 52.16  
 Wechsler, Michelle, 12.3  
 Weinstein, Karen J, 9.6  
 Weinstock, George, 2[9:30]  
 Weir, Jody S, 52.11  
 Weiss-Bilka, Holly E, 23[9:15]  
 Weiss, Mark A, 18[1:30]  
 Wellens, Kaitlin R, 26[9:15]  
 Werling, Kate, 52.20  
 Werren, Elizabeth, 5.8  
 Westaway, Kira, 22[11:15]  
 Westergard, Emily, 34.24  
 Westin, Jessica L, 50[Chair], 50.1  
 Weston, Darlene A, 17[1:15], 19.11  
 Weyher, Anna H, 12.8, 12.10  
 Wharry, Jeremy T, 10.5  
 Wheat, Amber D, 38[1:30]  
 Wheatley, Patrick V, 45[11:00]  
 Wheeler, Brandon C, 4[10:45]  
 Wheeler, Sandra M, 14.3  
 White, Bryan A, 2[10:15], 52.30  
 White, Frances J, 26[9:45], 31.31, 31.32, 38[1:00], 49.3, 56.5  
 White, Jacob C, 34.38  
 White, Leonard E, 50.6  
 Whitmore, Katie M, 9.41  
 Whittey, Erin, 32.21  
 Whymys, Pamela, 13.18, 13.19



## Author/Session Index

64

- Wichmann, Søren, 21.8  
 Wikberg, Eva C, 4[11:00], 60[2:30]  
 Wildman, Derek E, 1[9:00], 15[2:00]  
 Wilkins, Mary A, 42.1  
 Williams, Blythe A, 25[10:15]  
 Williams, Deborah M, 52.15  
 Williams, Frank L, 14.7, 30.4, 30.13  
 Williams, Jeff T, 27.10  
 Williams, Lana, 3[9:30], 9.15, 14.2, 14.3  
 Williams, LaShanda R, 52.27  
 Williams, Leslie L, 10.11  
 Williams, Scott A, 8.30, 30.1, 31.35, 57[2:45]  
 Williams, Sloan R, 9.24, 13.18, 13.19  
 Williams-Blangero, Sarah, 27.10  
 Williams-Hatala, Erin Marie, 17[3:00, 3:45], 30.18  
 Willis, Mary S, 54.3  
 Willmore, Katherine E, 2[9:00]  
 Wilson, Brenda A, 2[10:15]  
 Wilson, Mark E, 29.5  
 Wilson, Michael L, 26[9:30], 33.14, 52.13  
 Wilson, Richard K, 2[9:30]  
 Winchester, Julia M, 11.23  
 Winkler, Thomas W, 27.17  
 Winters, Sandra, 4[11:30]  
 Witt, Kelsey E, 6.10  
 Witt, William S, 31.17  
 Witzel, Adrienne, 39[3:45], 51.5  
 Witzel, Carsten, 9.42  
 Woldehawariat, Yitbarek, 54.3  
 Wolpoff, Milford, 44[Discussant]  
 Woo, Eun Jin, 10.24, 53.3  
 Wood, Bernard, 8.31  
 Wood, Warner J, 25[10:45]  
 Woods, Chris, 11.8  
 Worthington, Steven, 58[4:30]  
 Wrangham, Richard W, 1[10:30], 4[11:15], 7.4, 7.8, 60[2:45, 3:15]  
 Wray, Gregory A, 1[9:15], 52.39  
 Wright, Barth W, 30.7, 30.8, 52.28  
 Wright, Jonathan L, 27.16  
 Wright, Patricia C, 52.6  
 Wright, Stephanie, 41.4  
 Wroblewski, Emily E, 4[9:30]  
 Wu, Xiujie, 22[11:15]
- ### Y
- Yang, Deming, 11.19, 39[2:15]  
 Yano, Wataru, 23[9:00]  
 Yao, Lu, 52.43  
 Yapuncich, Gabriel S, 8.4, 8.6, 25[8:15], 31.21, 31.23  
 Yardumian, Aram, 18[1:45]  
 Yarlagadda, Karthik, 34.5  
 Yaussy, Samantha, 28.8  
 Yee, Mc, 18[1:00]  
 Yeoman, Carl J, 2[10:15]  
 Yepiskoposyan, Levon, 22[10:30]  
 Yetish, Gandhi, 1[11:30], 58[4:00]  
 Yi, Yoonjung, 42.11  
 Yoder, Anne D, 25[8:45]  
 Yokley, Todd R, 34.16  
 Yonemoto, Shiori, 9.39  
 Young, Janet L, 41.7  
 Young, Jesse W, 25[9:30], 31.11  
 Young, Johanna E, 9.12  
 Young, Kristin L, 27.14, 27.17  
 Young, Mariel B. W, 19.16
- ### Z
- Zakrzewski, Sonia R, 11.8, 41.4  
 Zaleski, Sarah M, 9.6  
 Zambrano, Carlos J, 32.32  
 Zamora, Andrew J, 52.6  
 Zeininger, Angel, 57[2:30]  
 Zejdlik, Katie, 6.6, 28[Chair], 28.3  
 Zhang, Quanchao, 53.19, 54.7  
 Zhang, Qun, 53.19, 54.7  
 Zhang, Qunyuan, 13.23  
 Zhao, Shanshan, 27.16  
 Zhu, Hong, 53.19, 54.7  
 Zhu, Yiliang, 27.11  
 Zichello, Julia M, 51.7  
 Zihlman, Adrienne L, 31.24  
 Zimmer, Adam C, 52.1  
 Zimmerman, Michael R, 13.4  
 Zink, Albert, 20[Discussant], 20.6, 20.7  
 Zink, Katherine D, 32.30  
 Ziomkiewicz, Anna, 37[3:45], 58[3:00]  
 Zipfel, Bernhard, 30.5, 57[2:15]  
 Zollikofer, Christoph P. E, 1[8:30], 15[2:15]  
 Zolotova, Natalya, 24[10:15]  
 Zuckerman, Molly K, 3[8:15], 10.14, 38[3:30]  
 Zwyns, Nicolas, 22[10:15]

**Body growth in wild mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda**

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Physical ontogeny is critical to understanding life history evolution. Great apes, including gorillas, have shown diverse life history strategies attributed to differences in their dietary ecology and social behavior. Virunga mountain gorillas are characterized by earlier ages at weaning, female first birth, and higher fertility compared to more frugivorous western gorillas. However, variation in postnatal growth among wild gorillas is poorly understood. We used non-invasive parallel-laser photogrammetry to characterize linear growth of six body measurements collected from wild Virunga mountain gorillas monitored by the Karisoke Research Center, Rwanda. In a pilot study of Zoo Atlanta gorillas (N=4), mean body measurements obtained using this method differed by 2.7-5.2% from corresponding measurements obtained manually. Head measurements, arm length, shoulder width and body length were collected from eight Karisoke social groups (N=63M, 52F; 0-35y) over four months, and growth curves generated for each sex using regression analysis; all data were treated cross-sectionally. For all measures, males and females showed similar growth rates from 0-8 years of age, after which time female growth slowed; adult female body length was reached by approximately 11 years. However, an interesting contrast emerged between wild mountain and western gorillas: male mountain gorillas reached adult body length by 14 years of age, which is 3.5 years earlier than reported for male western lowland gorillas at Mbeli Bai, Congo. These results support the prediction that mountain gorillas, characterized by reduced feeding competition associated with more folivorous diets, reach adult body size at earlier ages compared to western gorillas.

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**Morphological affinities of recently discovered Cercopithecids from the Pliocene Upper Laetoli Beds at Laetoli, in northern Tanzania**

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The Laetoli paleoanthropological site in northern Tanzania continues to yield one of the oldest *Australopithecus afarensis* collections as well as other well preserved non-hominin primate remains, including primate cercopithecids. The Laetoli primates are highly diversified, including fossil galagines, parapithecids and paracolobines. These primate species are indicative of highly variable depositional environments at Laetoli that would have been more wooded or forested with patches of bushes, thorn scrubs and open habitats. This research presents qualitative descriptions and a comparative computational statistical analysis (PCA and DFA) of odontometrics for the posterior teeth of fossil and extant primates as a way to securely classify recently recovered Laetoli fossil primate remains by the University of Colorado Denver Tanzania field school in paleoanthropology. The statistical analyses show that the posterior teeth can be used to distinguish speciation since tooth size can be indicative of dietary adaptations and habitat preferences. For instance, the PCA yields information on general groupings based on habitat preferences, whereas the DFA shows that the buccal teeth have a higher discriminatory power than the premolars; however M<sub>3</sub> has the highest discriminatory ability in deciphering primate species and exhibits the lowest misclassification percentage (15.88%) for all tooth types although it is known that it possess the highest variability in tooth size and shape. The results of this analysis and classification of unknown primate species provides a better understanding of the ecological diversity exploited at Laetoli during the Pliocene and contributes to our understanding of primate diversity and dietary behaviors at Laetoli.

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**Re-evaluation of Sexual Selection Theory for Canine Size in New World Monkeys: Implications for Pitheciine Primates**

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Variation in primate canine size dimorphism has been attributed primarily to sexual selection.

However, males and females are subject to different selective pressures and therefore canine size is expected to evolve differently between the sexes. We examine the influence of sexual selection on canine size in New World monkeys by looking at the relationships between canine size dimorphism with diet and mating system, while controlling for phylogenetic relationships. We obtained measurements for mandibular and maxillary canine height for 33 New World primate species. Consistent with previous studies, polygynous species have greater canine dimorphism and larger canines than species where males are monogamous. However, we found no correlation between female mating system and female canine height. Species that feed on seeds and fruits have significantly larger canines than species that feed on gum, fruit and insects, suggesting that in seed-eating species, diet may also influence male and female canine size. To further explore the influence of diet on canine size we compared four sympatric New World monkeys (*Ateles*, *Lagothrix*, *Pithecia*, *Callicebus*) from the Ecuadorian Amazon. Seed-eaters (i.e., *Pithecia*) allocated more time to foraging, and specifically foraging on seeds, than other monkeys again suggesting that seed-foraging plays an important role for the survivability and/or reproductive success of Pitheciines. This study suggests that while sexual selection better explains male canine size in New World primates, natural selection can also exert a selective pressure on both male and female canine size, especially in seed-eating primates such as Pitheciines.

**Degree of sexual dimorphism in odontometrics and arcade dimensions in modern American populations**

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Sexual dimorphism is an important component of the biological profile for both archaeological and forensic analyses. The pelvic girdle is widely accepted as the most diagnostic of sex, with the cranium often used as the second source of sex information. However, given differential preservation and recovery techniques of these areas, the dentition, with the well-preserved nature of enamel, is a useful source of information for the biological profile. Population-specific techniques are necessary, due to regional and ancestral variation.

Measurements were obtained from n=571 (n=255 males, n=316 females) individuals from the James K. Economides Orthodontic Collection at the Maxwell Museum at the University of New Mexico. The sample included n=202 Southwest Hispanics, n=161 Native Americans, n=43 Asian Americans, and n=165 European Americans. Through metric analyses of dental crown and cervical size of the polar teeth of the morphogenetic field theory and dental arcade

dimensions, degrees of sexual dimorphism were detected.

The results indicated differences in statistically significant variables ( $p < 0.05$ ) for each group and the degree to which such results are significant, with the mandibular incisors consistently showing the least sexual dimorphism. The mandibular canine displays significant variation of dimorphism, with Hispanics having the highest degree of statistical significance for crown and cervical dimensions ( $P < 0.001$ ) and Asian Americans exhibiting the lowest (only the mesiodistal crown diameter was significant). Differences in palate shape were detected in each population, particularly in the Hispanic and European samples. These results indicate utility in forensic and bioarchaeological contexts and suggest further development of population-specific sex estimation methods.

#### Newly discovered *in situ* primates and mammals from the early Pleistocene Haasgat deposits, South Africa

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The Haasgat palaeocave formed in dolomites of the western Schurveberg Mountains and filled with ~12m of fossiliferous early Pleistocene sedimentary deposits. Initial palaeontological excavations into *ex situ* lime-mining dumpsites generated a large faunal assemblage (HGD) with a notable diversity of extinct primates, including minimally two colobine species (*Cercopithecoides haasgati*, *Cercopithecoides williamsi*) and the largest described sample of *Papio angusticeps*. As an *ex situ* assemblage, however, there is little spatial and temporal context for dating the recovered fossils, reconstructing faunal depositional history, or establishing original species associations. Such baseline data is critical for establishing taphonomic and palaeoecological interpretations of Haasgat and the Pleistocene primate and faunal communities of the northern Cradle.

Here we present results from the first *in situ* excavations into the Haasgat deposits, including the first description of primate fossils from calcified and naturally decalcified palaeocave sediments. The recovery of well-preserved *C. haasgati*, *C. williamsi* and *P. angusticeps*

remains provides the first evidence for the age and depositional history of these primates within the deposits. The co-occurrence of these primates within the same/close stratigraphic horizons suggests contemporaneous deposition of these species. The recovery of associated primate craniodental and postcranial elements suggest the deposition of partial to complete skeletons. Depositional context for the *ex situ* mammal faunas is currently limited as few *in situ* non-primate fossils were recovered. While the dominance of primates in *in situ* samples limits broader interpretations of community structure and palaeoecology, these deposits record a significantly different primate community than typical of contemporaneous southern Cradle deposits.

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#### Evidence for assortative mating in recently admixed humans

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Assortative mating is the pattern of mates being more similar genetically or phenotypically than expected at random. Within humans, assortative mating between ethnic groups is well known and maintains genetic structure. Within groups, assortative mating is less well understood. Mexicans and Puerto Ricans have ancestry from Europeans, Africans and Native Americans, and have been found to mate assortatively with respect to these components. This pattern could be caused by several phenomena, including micro-geographical structure in the absence of any preference, actual preference for overall ancestry, or preference for similar phenotypes. We tested for assortative mating with respect to overall ancestry, individual genes, and genes known to be involved in phenotypic variation in Colombians (COL), Puerto Ricans (PUR), Mexican Americans (MXL), African Americans (ASW), Maasai (MKK), Han Chinese (CHS), and European Americans (CEU) using genomic SNP and mated pair data available from the HapMap and 1000 Genomes projects. We find significant assortative mating with respect to overall ancestry in COL, MXL, CHS, and CEU. We then used a sliding window approach to look at individual genes and found that loci with the strongest assortative patterns are often overrepresented for particular biological functions. For example, there are an abundance of genes involved in fertilization with an assortative pattern for European ancestry in MXL. Finally, we looked at genes known to be involved in phenotype, and found that MKK mate assortatively for genes involved in skin color, and ASW mate assortatively for genes involved in skin color and facial morphology.

#### Exploring the relationship between radiographic and osteologic measurements of the human os calcis

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Plain radiographs of the foot are a common form of examination in individuals when medical evaluation is indicated, because they provide information on bone morphology and angular relationships. Since plain radiographs are commonly performed, their availability makes them useful for studying human variation where large sample sizes are crucial. Calcaneal morphology is critical to understanding human foot form and function, but few studies have examined the accuracy of the measurements of the calcaneus taken from radiographs. If plain radiographs are to be used in quantitative analysis of the calcaneus, their accuracy must first be demonstrated.

For this study, fifty feet from amputated human limbs were collected, imaged in standard radiographic views, and skeletonized. Measurements that represented overall calcaneal length and height, and the height and breadth of the anterior process, were made on each skeletonized calcaneus and radiograph. The accuracy of the radiographic measurements was evaluated using paired Student's *t*-test and correlation analysis. All measurements are different (all  $p \geq 0.05$ ), but the overall calcaneal skeletal measurements are correlated (all  $r > 0.80$ , all  $p < 0.001$ ) with the radiographic measures. The anterior process height measures are also correlated ( $r = 0.56$ ,  $p < 0.001$ ), but the anterior process widths are not ( $r = 0.09$ ,  $p = 0.50$ ).

Measurements that are taken from the radiographic views provide useful information about the bony morphology of the calcaneus, suggesting that radiographs of living individuals can be evaluated quantitatively, compared to osteology collections of modern humans, and used in the interpretation of the hominin fossil record.

#### Investigation of craniofacial morphological variation at Sully (39SL4) utilizing patterns of postmarital residence

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This study utilizes a theoretical framework of modern quantitative population genetics to identify factors contributing to the morphological

variability between multiple, geographically distinct burial areas associated with the Sully village site (39SL4) in the Middle Missouri region of South Dakota. Three burial areas at Sully (A, D, and E) provide adequate samples for assessing intra-site variation. It has been a long-held belief that the observed morphological variability between burial areas is due to temporal sequencing; however, this explanation lacks hard craniometric and archaeological support. This study reassesses the assumption of temporal sequencing through the investigation of postmarital residence patterns. The practice of matrilocality and village endogamy has been reported for the Arikara in ethnohistoric accounts; this pattern is investigated using a geometric morphometric approach in conjunction with standard statistical analyses. Three dimensional coordinate data from 20 craniofacial landmarks from 69 Sully burials attributed to the Extended Coalescent are assessed. The coordinate data were translated, rotated, and scaled via generalized Procrustes analysis permitting the inclusion of both males and females in the samples, and fitted coordinates were subjected to principal component analysis. The resulting principal components are used as variables in three tests of homogeneity: Zhivotovsky's F-ratio, Wishart's bootstrap, and a nonparametric bootstrap. The results of these tests detect variable patterns of postmarital residence between the Sully burial areas, and when combined with alternate craniometric and archaeological evidence, may indicate possible clan-based burials at Sully.

#### **The Wenner-Gren Foundation and engaged anthropology**

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In 2012 the Wenner-Gren Foundation introduced a unique funding program, the Engaged Anthropology Grant (EAG), designed to provide funds to enable Wenner-Gren grantees to return to their research locale to share their research results.

Over the past decade, the Foundation has received ~12,000 applications for research funding. The EAG was introduced in response to the trend in these applications to ask for funds for a variety of engagement activities, from setting up local museum displays, to participating in educational or conservation activities, to engaging with the resident academic community. This trend also parallels the awareness of our ethical responsibility to disseminate our research results to the benefit of our research community and beyond.

Since the introduction of the EAG in February 2012, the Foundation has received 102 applications and has funded 68 (66.7%). We have been impressed by the variety of engagement activities and the enthusiasm and

dedication of our EAG grantees, most of whom are young anthropologists who were funded by Wenner-Gren for their doctoral research. This is a welcome trend.

In biological anthropology the engagement activities have ranged from projects involving indigenous groups in bioarchaeological research in Ohio, to enabling local school children in Uganda to be primatologists for a day, to engaging with the Turkana about the importance of palaeoanthropological research in northern Kenya. Our intention is that these and other EAG projects will inspire anthropologists to carry out similar research-inspired engagement activities. It is an important part of the future of the discipline.

#### **Radiocarbon Dating of Late Neanderthals in Southern Poland**

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The fate of Neanderthals has been extensively investigated in western and southern Europe, but less attention has been given to Neanderthals in northeast Europe. Numerous well-excavated, stratified sites in southern Poland have revealed archaeological assemblages thought to have been made by Neanderthals with Micoquian traditions. Here we present new finds and radiocarbon dates for human occupations of two such sites: Ciemna Cave, near Krakow, and Oblazowa Cave in the Western Carpathians. At both sites Micoquian traditions, and by inference Neanderthal occupations, seem to have ended by 45,000 calBP. This date suggests a temporal gap between the last Neanderthals and first modern humans in the region.

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#### **Body Height and Body Mass Estimations for Prehistoric Maritime and Terrestrial Hunter-Gatherers of Patagonia and Tierra del Fuego, Chile**

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Fuego-Patagonia (47°-56°S) has a long history of human occupation that extends from the Late Pleistocene (c. 10,500 BP) to modern times. In historic times, European and Criollos identified ethnic groups characterized by distinct terrestrial and maritime economic specializations. The archaeological record shows the first evidence for techno-economic specialization during Middle Holocene (c. 7000-4000 BP). During the 19<sup>th</sup> and 20<sup>th</sup> centuries ethnographic studies in the region describe maritime and terrestrial groups as phenotypically distinct. While terrestrial groups were tall and robust, maritime groups were short and gracile. This study assesses the height and body mass of prehistoric maritime and inland hunter gatherers from Fuego-Patagonia, Chile. Individuals were classified as terrestrial (THG), maritime (MHG) or indeterminate (IHG) hunter-gatherers based on their archaeological context. Stature was calculated using bicondylar femoral and tibial length, whereas body mass was estimated based on the superior-inferior breadth of the femoral head. Thirty individuals were included in this study (60% male, 33.3% female, 66.7% indeterminate). Based on their archaeological context, 50% were THG and 30% were MHG. The remaining 20% were IHG. Stature and Body Mass estimations show clear differences between these groups. While THG showed the highest stature and body mass, MHG showed the shortest and lightest. IHG individuals showed intermediate scores. Statistical analyses showed significant differences between THG and MHG in both stature and body mass (p<.05). The results confirm the observations made by early ethnographers in the region and indicate the existence of a phenotypical gradient in the region.

*Fondecyt 1140939*

#### **Population Structure in the United States: Using Forensic Data Bank Cases to Link Craniometric, Genetic and Social Information**

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This study combines craniometric clustering results with published genetic findings and documented self-identifications to provide a composite picture of population structure, ancestry variation, and personal identity in contemporary America. The unsupervised, model-based clustering methods of finite mixture analysis are used to reveal latent population structure and generate biological estimates of ancestry and proportions of admixture for craniofacial measurements representing known American Black, White and Hispanic individuals from the Forensic Data Bank. The results of these cranial analyses are compared against published data on genetic variation in the U.S. and the self-identifications for each case. Preliminary cluster results for a subset of the



FDB craniometric cases ( $n \approx 850$ ) reveal strong but complex population structure. Solutions, for which the number of  $k$  clusters exceeds the number of true groups, were favored by the model selection criteria and lead to within-population partitioning, suggesting that considerable heterogeneity exists within in each subgroup. Overlap is equally identified between clusters, implying instances of admixture or shared population history. This study shows how these factors, along with expected variability in self-identification, produce a complicated, often inconsistent, relationship between biologically-derived ancestry and sociogeographically-defined membership. In contrast, it reveals similarities in cluster patterns, ancestry estimates and admixture proportions produced from craniometric and molecular data analyses, recapitulating the relationship between neutral phenotypic and genetic variation. This study also explores changes to these patterns with increased sampling and additional skeletometrics. This study's findings are used to provide recommendations for cranial data analysis in forensic identification and when genetic data is also available.

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#### **Endocranial globularity and brain size in primates**

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Hypotheses connecting encephalization and basicranial flexion suggest that enlargement of the brain relative to basicranial length results in rostrocaudal expansion and basal flexion of the endocranium such that the brain achieves a more spherical or "globular" shape. Extreme neurocranial globularity and basicranial flexion of the "hyper-encephalized" genus *Homo* provide anecdotal support for this model. This project evaluates the prediction that a larger brain for a given body size will tend towards a more spherical shape—i.e. points on the endocranial surface are near equidistant to the endocranial centroid.

Phylogenetically informed regressions were employed to examine the relationship between interspecific residual endocranial volume (resECV), endocranial globularity, and basicranial angle (BCA) in 61 primate genera (20 platyrrhine, 26 catarrhine, 14 strepsirrhine, 1 tarsier). Three-dimensional landmarks were placed on virtual endocasts reconstructed from microCT scans of crania, capturing overall endocranial shape. A separate two-dimensional analysis traced the endocranial outline on associated midsagittal tomographs. Globularity

was quantified as the coefficient of variation among distances from each landmark to the endocranial centroid.

Haplorhines show greater two-dimensional midline globularity than strepsirrhines (Wilcoxon pairwise comparison:  $p < 0.001$ ). Among primates, humans demonstrate the most spherical endocasts. Midline globularity is correlated with resECV ( $p < 0.001$ ,  $r^2 = 0.28$ ) and BCA ( $p < 0.0001$ ,  $r^2 = 0.30$ ); however, three-dimensional globularity is not correlated with either variable ( $p > 0.1$ ). Multivariate analyses of endocranial shape indicate the inconsistent relationship between globularity and encephalization results from broad diversity in endocast shape, owing in part to features influenced by variation in brain proportions (relative volumes of brain parts) within and among clades.

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#### **Evolutionary history of ape and human hand length proportions**

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The human hand is a unique region of the postcranial skeleton that appears derived in comparison to "the ape condition" by exhibiting long thumbs relative to the fingers (thereby facilitating enhanced manipulation). However, this ape-human dichotomy is too simplistic and does not provide an adequate framework for interpreting hominin evolution—was there digital reduction, thumb elongation, or both? We test these competing options by analyzing the length proportions of the hand (long bones of the thumb and ray IV) relative to each other and to overall body mass. We also model the evolution of these proportions in apes and humans using maximum likelihood with fossils as calibration points, and including several non-hominoid anthropoids as out-groups.

Our results show that extant apes are heterogeneous in terms of hand and thumb proportions, and these differences are not simply explained by allometric scaling. Moreover, our evolutionary modeling reveals that the last common ancestor of chimpanzees and humans (LCA) exhibited a moderate hand length (closer to humans than to chimpanzees). Under different phylogenetic hypotheses, our results imply that hand elongation was achieved independently and to different degrees in the extant and fossil ape lineages, and through distinct evolutionary pathways (possibly in response to adaptations for

suspension). The hypothesis that we favor is that (relative to the LCA) humans have modified their hand proportions just slightly, probably in response to manipulative selective pressures. These results highlight the prevalence of homoplasy and mosaicism in ape and human evolution, and are congruent with the available fossil record.

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#### **Burial laws and protocols: Elucidating processes and optimizing strategies via the Taphonomic Information System (TAPHONOMIS)**

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A complex assortment of environmental variables (e.g., temperature, humidity, insect and animal activity, vegetative cover, deposition rate, burial deposit chemistry) play roles in the postmortem processes that act upon soft tissue and bone. Many of these taphonomic effects have been quite well characterized at macroscopic and microscopic levels, although regional variation continues to be of interest. Taphonomic processes also govern the potential for informative molecular analyses (e.g., DNA, amino acid, and isotopic studies). Various properties of a burial deposit (e.g., sand/silt/clay composition, moisture content, acidity or alkalinity, presence of certain minerals), can determine not only whether potentially-informative molecules are preserved, but also which laboratory methods would be the best choices for detecting these molecular constituents within a given specimen or context.

The Taphonomic Information System (TAPHONOMIS) is a relational database designed to accommodate the wide variety of relevant environmental variables, specimen properties, and laboratory strategies; and to facilitate the compilation and multivariate analyses of these data. TAPHONOMIS provides a repository for published and unpublished data, and a venue for sharing details on environment/protocol combinations that have – and have not – generated high-quality results.

Data from a selection of paleoanthropological, archaeological, forensic, and experimental studies have been used to validate the functionality of the system, and provide interesting case studies for its utility in delineating taphonomic relationships. A more comprehensive understanding of these relationships will benefit the paleoanthropological, archaeological, and forensic communities, by assisting in the



selection of optimal analysis methods and informing the interpretation of study results.

**Determinants of the gut microbiota of Mesoamerican howler monkeys (*Alouatta pigra* and *A. palliata*)**

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Understanding primate-gut microbe interactions is critical in primate ecology and conservation. For example, the gut microbiota of Mexican black howler monkeys (*Alouatta pigra*) appears to have a nutritional buffering effect across seasons, while in degraded habitats, it may exacerbate reductions in host nutrition and health. We hypothesized that habitat would impact both the black and mantled howler monkey gut microbiota similarly, that the gut microbiota would shift less markedly across seasons in fragmented forest than in continuous forest, and that differences in the gut microbiota across habitats would be reduced during seasons of reduced fruit intake.

Fecal samples were collected from howler monkeys at two sites (Palenque National Park, Mexico and Ometepe Island, Nicaragua). Mexican howler monkeys were sampled repeatedly across several years and seasons. Nicaraguan samples were collected at two time points, including dry season and wet season. Analyses are based on high throughput analyses of 16S microbial rDNA to assess microbial taxa represented

Our data support the last two hypotheses in black howler monkeys. However, we found that while the gut microbiota of the mantled howler monkey was qualitatively similar to that of the black howler monkey, the mantled howler monkey gut microbiota responded differently to changes in habitat compared to the black howler monkey gut microbiota.

These findings suggest that different host species have distinct relationships with their gut microbiota and that integrating gut microbial processes into ecological models will require detailed data for each primate species.

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**ARE YOU READY TO RUMBLE?! Sports Championship Mimicry to Educate about Adaptations, Community Ecology, and Conservation**

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Annually since 2013, in honor of the NCAA College Basketball March Madness Championship Tournament, the blog “Mammals Suck... Milk” features simulated combat competition among 65 species of animals in a virtual tournament. Scientific literature is cited to substantiate likely outcomes should two animals or two groups of animals encounter one another. Battle outcome is a probabilistic function of the two species' attributes within the battle environment. Attributes considered in calculating battle outcome include temperament, weaponry, armor, body mass, running speed, fight style, physiology, and motivation. During early rounds, battles occur in the better-ranked species' habitat (home court advantage); in later rounds, battle locations are randomized among multiple ecosystems. Thousands of people play Mammal March Madness each year, including museum collections staff, high school science classes, college biology and anthropology courses, and families. Animal combat bouts during Mammal March Madness are simulated in near “real time” using the microblogging site Twitter. Each evening the results are aggregated, along with public commentary, via the social network repository Storify and linked from the hosting blog as well as shared through online social networks. Through the scientific information embedded in the bout descriptions and peer contributions from animal aficionados and experts in a variety of fields, participants are educated about inter-species interactions, the importance of ecological context, how natural selection has shaped adaptations, and conservation management of endangered species. Mammal March Madness is a pedagogical innovation that engages people from around the globe, creatively integrates digital technologies, and inspires awe for the natural world.

**Cranial shape and intrageneric diversity in the genus *Cercopithecoides***

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The fossil colobine genus *Cercopithecoides* is temporally, geographically, and morphologically diverse. There are currently six species recognized from Late Miocene to Pleistocene sites in Africa with a possible seventh form present at Kromdraai B and Swartkrans in South Africa, for which the name *C. coronatus* (Freedman, 1957) is available. We focus on the cranial morphology of *C. “coronatus”* to both evaluate its affinities with other *Cercopithecoides* species and assess whether the observed differences are sufficient to warrant separate taxonomic status.

Three-dimensional cranial landmarks, linear measurements, and dental metrics were taken on 294 crania, 422 upper and 565 lower molars of extant and fossil colobines. The *C. “coronatus”* crania are most similar in shape, size, and molar size to *C. kimeui*. Most species of *Cercopithecoides* share a similar molar size to cranial size ratio, although *C. haasgati* specimens stand out for having large teeth relative to their cranial size. Principal components analysis separates *C. “coronatus”* from other South African taxa and plots them closest to *C. kimeui*. In brow thickness, *C. “coronatus”* overlaps the ranges of *C. kimeui*, *C. meaveae*, and *C. williamsi* while *C. haasgati* and *C. alemayehui* are notably smaller. Overall, our analysis shows the presence of a large species of *Cercopithecoides* in South Africa similar in both dental and cranial size and shape to East African *C. kimeui*. Further analyses are necessary to determine whether *C. coronatus* can be recognized as a distinct species or whether *C. kimeui* should be recognized as a junior synonym of *C. coronatus*.

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**Geospatial Paleoanthropology: predicting and locating new fossil localities with approaches from the spatial sciences**

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Collaboration between a team of paleoanthropologists, vertebrate paleontologists, geologists, and geographers suggests new approaches to identify fossil localities informed by the geospatial sciences. We utilized different remote sensing strategies and imagery to visualize and predict the presence of fossil-bearing deposits in Eocene sediments of the Great Divide Basin, Wyoming. Our approaches are multiscale, ranging from supervised classifications of basin-wide Landsat imagery, to a more local approach involving high resolution commercial satellite imagery, to highly-local, low elevation reconnaissance flights using an unmanned aerial vehicle (UAV) equipped with an HD video camera. During the past two summer field seasons our team has ground-truthed predictions derived from both predictive models. During summer 2013 we visited 31 predicted locations and collected vertebrate fossils at 13, resulting in 25 new fossil localities. During summer 2014 we visited 8 locations and found fossils at 6 of these, yielding 10 new localities. During our 2014 field season we tested the utility of an unmanned aerial vehicle (DJI Phantom Vision 2+) for "remote prospecting" of sediments. We flew the UAV at very low elevations watching a live video feed (on smart phone) of surficial sediments to determine their nature. We also used the UAV to collect "bird's eye" imagery of a sandstone locality to photogrammetrically develop a 3-dimensional model of the outcrop. These approaches from the geospatial sciences can help us locate additional fossil resources, share spatial and fossil data with colleagues and the public, and better understand the geomorphological nature and taphonomic history of individual fossil localities.

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#### **CT scan 3D visualisation of atheromas in Egyptian mummies: potential, limitations and the need for a more systematic approach**

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Eight Egyptian and Sudanese mummies ranging from 3500 BC to AD 700 were recently CT scanned as part of the *Ancient Lives, New Discoveries* exhibition at the British Museum. Out of the eight mummies, six were artificially embalmed and two were naturally preserved by the hot and arid desert conditions. CT scanners, including the latest Siemens Dual Energy CT scanner, were used to analyse their remains without unwrapping them. Advanced visualisation software (VGStudio MAX) was used to generate a detailed three-dimensional

model of each mummy. The arteries of the six adult mummies were explored for signs of cardiovascular disease and, when possible, high resolution images of the pubic symphysis were generated to assess their age at death. In the two natural mummies, arteries were preserved throughout their bodies, whereas in the artificially mummified remains, many organs and surrounding vessels had been removed by the embalmers. Calcified plaque deposits believed to be atheromas were found in two of the artificially mummified bodies (both distal femoral arteries in one, the medial circumflex medial artery in the other). The three-dimensional models made it possible to study, in great detail, the relationship between the calcified deposits and their surrounding tissues, as well as assess which arteries had survived mummification. The systematic recording of all preserved arteries – whether or not affected by atherosclerosis – allows for a clearer assessment of the past prevalence of cardiovascular disease.

#### **Size and scaling between teeth and jaws in genus *Homo***

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Human evolutionary history is marked by several inferred dietary shifts including to a higher quality, less tough diet at the base of the genus *Homo*. The masticatory apparatus often reflects long term dietary shifts by changes in morphology of the teeth, jaws and other cranial components and at the same time also reflects other, nonfunctional phylogenetic signals. Currently, three semi-contemporaneous species are hypothesized for early African *Homo*, based in part on differences in the teeth and jaws. An alternate hypothesis suggests these differences reflect intraspecific variation. These hypotheses are difficult to test given that mandibular and dental size are rarely analyzed in tandem. We investigate the relationship between teeth and jaws in humans (n= 415) and early fossil *Homo* (n= 18) in consideration of these hypotheses regarding taxonomic diversity. Using mandibular cross-sectional properties from CT and laser scans, 2d and 3d metric data and dental crown base areas we investigate the relationships between tooth area/proportions and mandibular size and shape. The human samples are geographically diverse and controlled for cranial shape but vary in inferred diet/paramasticatory activity from more challenging diets (e.g., Inuit) to less challenging diets (e.g. modern urban samples). While size and shape vary, regional/population level scaling of teeth to jaws appears consistent across human samples and only moderately influenced by inferred diet. Against this backdrop (and assuming the human sample is representative of intraspecific variation), the combination of dental and

mandibular data appear to suggest differences across the fossil specimens that are consistent with interspecific variation.

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#### **Effects of menstrual cycle phase on thermoregulation variation**

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All endotherms regulate temperature to avoid reaching potentially harmful body temperatures. Human females have an interesting additional pressure because their body temperature varies along with their menstrual phases, though the temperature at which body functioning decreases does not change. Women have a higher core temperature during luteal phase due to the actions of progesterone on the hypothalamus. Thus, when women are most fertile, they are also at increased risk for overheating and potentially damaging their developing embryo. Women should thus have evolved physiological and/or behavioral strategies for negotiating the balance between maintaining mobility (e.g. heat increasing activity) and thermoregulatory homeostasis during luteal phase. Here we test physiological strategies of women (N=12) in different menstrual phases by monitoring their metabolic rate, core body temperature, and skin temperatures while they perform a series of rest and exercise bouts. During resting periods women in luteal phase maintained a narrower range of metabolic rates than women in follicular phase (luteal phase women maintained a 53.8% smaller range); additionally, luteal-phase women exhibited a smaller average change in core body temperature (luteal phase: +0.69%, follicular phase: +1.65%). Thus, women in luteal phase do appear to control key physiological variables more successfully than women in follicular phase. Part of the mechanism appears to be heat dumping as evidenced by dramatic increases in skin temperatures proximal to the heart (neck: 13.6%, bicep: 28.7%). It also remains likely that behavioral mechanisms are also utilized.

#### **Feeding the city: Isotopic reflections of diet at 1<sup>st</sup> century Petra, Jordan**

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Petra's urban fluorescence in the 1<sup>st</sup> century A.D. implies that city residents had eschewed their formerly nomadic existence and fully embraced a sedentary lifestyle. However, little is known whether or not local agricultural fields in this arid environment could have fully supported the diet of city residents, let alone provided fodder

for meat sources such as sheep and goats. Paleobotanical, archaeological, and papyrological data indicate that local agricultural production included water-intensive C3 plants such as barley and wheat along with more environmentally-suitable C4 plants such as millet. In addition, herd animals were brought in “on the hoof” for consumption based on zooarchaeological data. Here, we analyze carbon and nitrogen isotopes of non-elite inhabitants of Petra from the North Ridge Tombs to understand to what extent city residents relied on C3 plants and animal protein, items likely supplemented by imported sources due to the city’s environment, and the variability of the city residents’ diet. The relatively similar  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  bone collagen and apatite values from 34 individuals suggest that a typical Petraean diet consisted mostly of C3 plants, likely comprised of local and imported grains as local production could not have supported the urban population that was supplemented significantly by animal sources. These results not only provide indication of the city’s reliance on imported foodstuffs, but also will allow more informed interpretations of other isotope data on population mobility.

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#### **Counting Calories, Counting Culture: Considerations for Diversity and Food-Based Dietary Guidelines**

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The Department of Health and Human Services publishes an updated set of dietary guidelines geared toward the American public every five years. Despite written recommendations unique to “specified populations,” comparably little seems to account for our nation’s multicultural composition. Such discrepancies become especially manifested in pictorial representations of food-based dietary guidelines (FBDGs), which essentially distill recommendations into a uniform image whether it be a pyramid, set of steps, or most recently a plate in the American context. This paper presents an opportune moment to reflect on the *Dietary Guidelines for Americans*—in advance of its 2015 release—within the context of global dietary diversity and human variation. Comparing the aforementioned guidelines with those around the world allows for worldwide variation in diet to be explored, as well as expected caloric intake compared to energy expenditure of world cultures. Through a literature review and survey of 24 contemporary pictorial representations of FBDGs, and a quantitative analysis of caloric data of select populations, we emphasize the political economy of biological and cultural outcomes around diet (i.e., the politics tied into the representation of food choices defined biologically and culturally) and its implications for dietary guideline efficacy

in both written and pictorial form. We suggest efficacy is contingent on the ability to make guidelines relevant to cultural groups and representative of intragroup diversity. Further, we stress the importance of addressing and sustainably resolving access issues and systemic inequalities both on a national and global scale.

#### **Bergmann’s rule in skull size of wild vs. captive *fascicularis* group macaques**

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Bergmann’s rule predicts that body size increases with distance from the equator. This pattern has been noted in wild macaque populations, but captive populations relocated to new latitudes have not been examined for this pattern. They are therefore a prime population for analyzing whether Bergmann’s rule is influenced more by natural selection or developmental plasticity.

Forty-five 3D cranial landmarks were collected using a Microscribe-3DX on a sample of 199 adult crania from wild populations of *Macaca fascicularis*, *M. cyclopsis*, *M. fuscata* and *M. mulatta* with known provenience, as well as 18 captive *M. mulatta* from Beaverton, OR and 40 from Cayo Santiago, Puerto Rico. Both captive populations originated with wild-caught individuals from India in the 1960s and 1970s. Centroid size was then calculated for each specimen as a proxy measure of body size.

Latitude explained more variation in centroid size in wild macaques (males  $R^2=0.319$ ,  $p<0.0001$ ; females  $R^2=0.371$ ,  $p<0.0001$ ) than did mean annual temperature (males  $R^2=0.247$ ,  $p<0.0001$ ; females  $R^2=0.257$ ,  $p<0.0001$ ). The Beaverton (lat=45.5) and Cayo Santiago (lat=18.2) populations showed no significant difference in male cranial size ( $p>0.200$ ), but Cayo Santiago females were significantly larger than those from Beaverton ( $p<0.001$ ), the opposite relationship than predicted by Bergmann’s rule. Predicted latitudes for both populations based on cranial sizes (Beaverton males=20.1, females=20.2; Cayo Santiago males=21.7, females=25.6) are closer to latitudes of population origin than their current captive locations. This suggests the latitudinal pattern of skull size in wild *fascicularis* group macaques is more influenced by natural selection than developmental plasticity.

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#### **Evidence of Paleohistorical Atlantic and Pacific transoceanic genetic and cultural contacts**

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It’s has been shown that transatlantic cultural (Solutrean North Spain/France) and/or gene exchanges may have occurred between America First Inhabitants and people coming from southern Europe; Pacific Ocean and American exchanges may have also been possible in antiquity. We have studied: 1) HLA genes in Aymara (Titikaka Lake Area First Inhabitants, Bolivia) and many other Amerindian, Asian, Pacific Islanders and Mediterranean populations, by using Arlequin software programs for obtaining genetic distances and Neighbour Joining relatedness dendrograms. Also, correspondence analyses among populations were carried out. A total of 7,200 chromosomes were analysed, 2) Aliberite Dolmen (Cadiz, southern, Spain) and Titikaka Lake Tiwanaku culture characters, particularly those related to sound amplifications 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 (Kon Tiki, 1947) about South America and Easter Island contacts, b) Genetics needs to be contextualized in the frame of other knowledge areas, like Anthropology and Archaeology in order to obtained more information about World populations origins and Americas peopling. Finally, Genetics by itself have been unable to satisfactory 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 Europe mainland in prehistoric time is discussed.

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#### **The Body Mass of *Victoriapithecus macinnesi* Revisited Using Foot Remains**

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Body mass estimates of *Victoriapithecus macinnesi* from Maboko Island provide insights into the paleobiology of early cercopithecoids, including their relative brain size and degree of sexual dimorphism. Previous estimates using several postcranial elements ranged from 2.4-4.1



kg while craniodental remains yielded estimates from 4.5-7.5 kg. Generalizations about the paleobiology of *Victoriapithecus* from previous body mass calculations of postcrania are limited, however, by the fact that they were based solely on comparisons with samples of a single extant species, the vervet monkey (*Chlorocebus aethiops*) and primarily involved long bones.

This study seeks to improve estimates of body weight of *V. macinnesi* by using foot bones which are used extensively for weight-support. The range of species used to generate regression equations is expanded and only individuals of known body mass (specimens from the Museum of Comparative Zoology and a population of wild-caught *C. aethiops* from Kibwezi, Kenya) are used. Based on the expanded sample of colobine and cercopithecine monkeys, body weight estimates for *Victoriapithecus* fall into a bimodal distribution clustering around 3.1-3.6 kg (presumably female) and 4.1-4.7 kg (presumably male). These results support the claim that *V. macinnesi* was moderately sexually dimorphic, similar to *Rhinopithecus roxellana*, *R. bieti*, *Cercopithecus nictitans*, *C. petaurista* and *Macaca fascicularis*. Using only species that are frugivorous like *Victoriapithecus*, body mass estimates were slightly larger, ranging from 3.1-5.2 kg, but are still smaller than the craniodental estimates. Higher estimates from craniodental remains could be the result of a diet of hard fruits selecting for its megadont condition.

#### The YNH4: Multidisciplinary review of skeletons from New Haven, CT's first Roman Catholic Church cemetery reveal ancestry, economic, social and health indicators

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In July 2011, renovations to Yale-New Haven Hospital accidentally exposed the cemetery of Christ Church, New Haven's first Catholic cemetery. This cemetery was active between 1833 and 1851, but both the church and its cemetery disappeared from public records, making its discovery a surprise.

Four relatively well-preserved adult skeletons were recovered with very few artifacts. Two are relatively older individuals, and two younger. All four individuals show indicators of manual labor, health and disease stressors, and dental hygiene issues. Two show indicators of trauma. Musculoskeletal markings are consistent with physical stress, and two individuals have arthritic indicators of repetitive movement/specialized activities. Radiographic analyses show osteopenia, healed trauma, and other pathologies in several individuals. Isotopic analyses of bones and teeth indicate that three of the four were recent immigrants to the Northeast USA, and the diet of all four likely contained both marine and terrestrial components. Nuclear and mitochondrial DNA were recovered from three individuals, and these analyses identified ancestry, hair/eye color, and relatedness –and also upended our initial ancestry assessment based on burial context alone.

These individuals provide biological evidence of New Haven's Industrial Revolution. Their recovery and the systematic analyses described here illuminate a largely undescribed part of the city's rich history. The combined expertise of biological, archaeological, and historical researchers collectively interpret features of identity, society, and urban life better than any one could alone. Our combined efforts changed our initial assumptions of a poor Catholic cemetery's membership, and provide a template for future discoveries and analyses.

#### Phylogenetic analysis of the Sima de los Huesos hominins and evolutionary patterns in the Middle Pleistocene

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The Sima de los Huesos (SH) skulls constitute the largest collection of a fossil hominin species ever recovered from a single site, making it possible for the first time to thoroughly characterize a Middle Pleistocene hominin paleodeme and to address hypotheses about the origin and evolution of the Neandertals and modern humans. The SH fossils show derived Neandertal features in the facial skeleton and areas that are related to the masticatory apparatus. This suggests that facial modification was the first step in the evolution of the Neandertal lineage, prior to neurocranial changes, pointing to a mosaic pattern of evolution. The chronology established for the SH hominin fossils, based on several independent

techniques with reproducible results, provides a firm terminus ante quem age of ~430 ka, making the SH hominins the oldest reliably-dated fossils to show clear Neandertal apomorphies. Although considerable debate remains over the suitability of existing taxonomic classifications, we suggest that the SH sample be removed from the *H. heidelbergensis* hypodigm. It is becoming increasingly clear that more than one evolutionary lineage appears to have coexisted during the European Middle Pleistocene, with that represented by the SH sample being phylogenetically closer (i.e. sister group) to the Neandertals.

The development of more widespread and reliable age control is critical for unravelling the evolutionary histories and phylogenetic relationships of the European Middle Pleistocene record.

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#### The patterning cascade model and Carabelli's cusp expression in metamerer of the mixed human dentition: exploring a morphogenetic model

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The patterning cascade model (PCM) predicts that accessory cusps will be larger and/or more frequent in teeth that are larger and/or possess more closely spaced secondary enamel knots. The PCM has successfully predicted Carabelli's trait (CT) expression in the permanent molar row. However, the ability of the model to predict accessory cusp expression in elements within the mixed molar row has not yet been studied. We tested whether the PCM predicted CT expression in paired deciduous second (dm2) and permanent first (M1) molars (n=49 individuals). It has been reported that CT is often more strongly expressed in dm2 despite its reduced crown size. If this is true, we hypothesized that differences in relative inter-cusp distance would explain variability in CT expression within and between metameres.

We found that in 69% of cases where dm2 and M1 differed in ASUDAS scores, CT expression was stronger in dm2. Paired t-test results showed the predicted negative relationships between mean relative inter-cusp distance and CT expression, although contrary to previous studies, these results were not statistically

## AAPA Abstracts

significant. Significant negative correlation was found between CT expression and relative protocone-paracone distance for dm2, but not for M1. Our findings support other studies that suggest ultimate crown morphology results from interactions between genetic and developmental factors. We suggest that exploring variability in individual inter-cusp dimensions may provide more detailed insight into morphogenetic programs.

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### The genetics of brain cortical folding in the baboon

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Folding of the cerebral cortex is a relatively poorly understood but evolutionarily significant phenotype with far-reaching implications for brain development and function. Using a pedigreed population of ~1000 *Papio* baboons, we investigated critical questions about the genetic architecture of primate cortical gyrification, the interplay between genetics, anatomy, development, and connectivity, and gyrification's potential for future evolution.

Our analyses of cortical features in CT-scan-based virtual endocasts find 14 out of 20 metric traits are significantly heritable (mean  $h^2=0.26$ ), while non-metric shape features are more environmentally labile. Using Mantel testing and cluster analysis, we detect significant similarity in the pattern of variation between the genotype and phenotype, which would allow for ready future adaptive alteration of the cortex. Similar partitioning of variation was also detected between development, anatomy, and connectivity (the neural network). This provides indirect support for the predictions of tension-based models for cortical development and evolution over competing models. Finally, we identified 18 novel QTL affecting variation in gyrification (highest LOD=3.23, trait Llu) and parsed the genetic architecture for this complex phenotype, finding both polygeny and pleiotropy in this population.

This inter-disciplinary project characterized the genetic basis of variation in cortical gyrification

and investigated the biological underpinnings contributing to structural and, ultimately, functional differences in the cerebral cortex between primate species. Our findings provide a foundation for further examination of the molecular causes of variation in primate brain folding. Though this work was done in the baboon, the results are more widely applicable and inform human genetics and neuroscience.

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### Estimating variance in femoral head size against body mass estimation: implications for evolution and integration

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Auerbach and Ruff's 2004 study showed correspondence in mechanical and morphological approaches to estimating body mass in humans. However, approximately 40% of the variance between estimations is unexplained, and small-mass groups have large femoral heads for their expected masses. Subsequent research indicates that femoral head size does not ontogenetically match body mass, but rather follows growth in femoral length (Ruff, 2007). Thus, while femoral head size mechanically relates to body mass, these prior results collectively indicate that underlying covariance between femoral length (a major component in morphological body mass estimates) and femoral head size may be driving the correspondence between the two body mass estimation methods.

Here, resampling methods are used to compare variance in femoral head diameter (FHD) within groups against morphological body mass estimates (MorBMEs) and femoral lengths (FMLs). In each of 20 groups in the Goldman Data Set, mean FHDs, MorBMEs, and FMLs, standardized by the dimension, were calculated from subsamples for 1000 iterations. The distributions of these were then compared using parametric methods. Results show that the distributions of FHDs significantly differ from MorBMEs, and that the differences between the distributions of these dimensions are stochastic among groups. In contrast, FHD distributions are not consistently different from FML distributions. Femoral head size varies independently of MorBMEs within groups, while FHD and FML are less independent. MorBME, then, may correspond well with FHD body mass estimates largely due to covariance between the femoral dimensions. Further implications for morphological integration and evolution among small-mass human groups are considered.

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### Digitizing Standards with OsteoSurvey: A case study in open access data collection at Deir el-Medina, Egypt

ANNE E. AUSTIN. Department of History, Stanford University.

*Standards* has allowed researchers to collect and compare data across sites for decades, but conducting these comparisons is often complicated by a lack of access to additional data sets and the time required to compare them. In this poster, I demonstrate how to use open-source software to collect, publish, and compare osteological data sets through a case study on data collection at the Egyptian New Kingdom site of Deir el-Medina.

During the 2012-2014 seasons, I collected osteological data on 1,061 elements using *OsteoSurvey*, a tablet-based data collection program that uses methods from *Standards* and *The Data Collection Codebook for the Global History of Health Project*. *OsteoSurvey* allowed the data to be instantly uploaded to a secure server, enabling remote access. Additionally in 2014, a separate data set of over 2,000 elements was collected using *OsteoSurvey* in Chinchá, Peru by the Chinchá Valley Archaeological Project (osteological research lead by Brittany Jackson).

I offer three ways to directly improve data collection through the use of digital data collection software. First, I offer a live demonstration on how to use and access *OsteoSurvey* to enable faster and more accurate data collection. Second, I demonstrate how modular digital data collection protocols allow fast and easy comparison of data collected at Deir el-Medina with data from Chinchá, Peru, despite different research agendas. Finally, through the use of tDAR and Google Applications, I show steps to store data online both securely and permanently in order to facilitate comparison with multiple data sets.

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### The sum of their parts: Assessing double-zonal osteons within medieval Kulubnarti, Nubia

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Histological studies of bone represent an effective means of reconstructing health and estimating age in ancient populations through frequency and size analyses of osteons. Although secondary osteons have been studied extensively, double-zonal osteons are atypical and are not entirely understood. Previous research suggests that double-zonal osteons may represent periods of growth arrest due to physiological stress. In this study, rib thin sections from 51 individuals, between ages 15-50+, from medieval Kulubnarti, Nubia were examined to assess whether double-zonal osteon frequencies vary with age and sex.

Thin sections were observed using a compound light microscope. Frequencies of double-zonal osteons were counted for each rib section. Section areas were determined using Image J. Results show that double-zonal osteons demonstrate a strong, significant negative correlation with age (Spearman's rho = -0.572;  $p = .000$ ). A Mann Whitney U test showed no statistically significant difference between the sexes ( $p = 0.118$ ). The negative correlation with age for double-zonal osteons is particularly interesting given the pattern of an overall increase in osteons with age. Previous research on the Kulubnarti sample has demonstrated the presence of generalized stress. Double-zonal osteons decrease with age, supporting the hypothesis that they represent periods of growth arrest, as individuals with more double-zonal osteons appear to have a higher risk of dying. However it is unclear whether the patterns suggested by this study are population or bone-specific. Future histological studies will incorporate data from other elements and other skeletal samples.

#### **A re-evaluation of the Down syndrome diagnosis for LB1 (*Homo floresiensis*)**

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The type specimen of *Homo floresiensis* (LB1), a small-bodied species with its roots in Plio-Pleistocene *Homo*, was recently diagnosed with Down syndrome (DS). In the absence of cytogenetic data for LB1, the diagnosis was based on 17 of the >80 clinical signs of DS argued to be present in the LB1 skeleton.

We re-evaluated these claims using comparative data from the Liang Bua hominins, modern humans with DS, and unaffected modern humans. Many of the putative signs were not present in LB1 (e.g., LB1 has a frontal sinus), or differed significantly in their anatomical presentation from that seen in DS individuals (e.g., flat feet, flaring ilia). Moreover, estimated stature and brain size of LB1 are outside the range of values reported for adults with DS, and LB1's body shape is not typical of DS. We identified additional signs of DS not addressed in the initial diagnosis that are also absent in LB1, including thin cranial bones, midfacial hypoplasia, and a posteriorly flattened occiput.

Down syndrome is best viewed as a complex genetic disorder, where the specific phenotypic manifestations in a given individual are products of genetic, environmental and stochastic influences. As any particular DS individual will present only a subset of the >80 clinical signs of this disorder, trait-by-trait enumeration cannot provide a competent diagnosis of DS, and the absence of individual features does not rule out a diagnosis of this disease. Nevertheless, the existing evidence does not support this diagnosis, and LB1 remains the type specimen of *Homo floresiensis*.

#### **Evolution of gene expression network underlying a disease state in humans and non-human primates**

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We used a comparative approach to understanding differential disease susceptibilities between closely related species. Humans and chimpanzees have very similar genomes, but have different susceptibilities to a number of diseases. We tested one of these disease phenotypes, epithelial cancer progression, in cell culture. Previously, we found that many of the genes involved in this pathway show signals of positive selection in putative *cis*-regulatory regions. Presumably these changes are advantageous at other life-history timepoints. Other studies have shown that when human fibroblasts are starved and then exposed to serum, they undergo a transcriptional response that involves categories of genes that are highly correlated with gene expression signatures found in human epithelial cancers. We have now performed this same experiment on human and chimpanzee cell lines, using RNA-Seq and DNase-Seq (a measure of open chromatin) to understand how these species react differently to this important physiological response. Our results suggest that there are a number of important gene expression pathways that have changed over evolutionary time to respond to this stressor and there have also been significant changes in enhancer usage over evolutionary time. This experiment provides insights into the

genetic pathways underlying the known differences in carcinoma rates between humans and chimpanzees.

#### **What facilitates facultative allomaternal care in red-bellied lemurs (*Eulemur rubriventer*)? A preliminary investigation**

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Allomaternal care (AMC), or infant care provided individuals other than the genetic mother, is prevalent throughout the Order, suggesting strong selection for this behavior early in primate evolution. Here, we report preliminary results from our study investigating the evolution of AMC in the red-bellied lemur (*Eulemur rubriventer*), a seasonal breeder with facultative AMC. Study groups (N=10) were followed from dawn-to-dusk during two consecutive birth years (August-April 2013; June-April 2014) at Vatoharana in Ranomafana National Park, Madagascar. We used instantaneous group scans and continuous focal infant sampling to record data on activity budgets, infant care, and proximity to mother and infant. Behavioral landmarks of infant development were recorded ad libitum. Fecal samples from all subjects were used to estimate kinship and to monitor hormonal changes in AMC providers prior to and following parturition. Using nonparametric statistics, we evaluated how natural variation in AMC (i.e., presence/absence, rate, type) is associated with 1) the intrinsic qualities of helpers (sex, age, kinship); 2) litter size (singletons vs. twins); 3) hormonal changes (i.e., cortisol and androgens), and 4) infant survival. Results indicate that AMC varies among individuals, as well as across groups and years. Presumed fathers were the primary AMC providers (mean=95.2%), followed by juvenile females (mean=4.8%) and males (mean=0%). Litter size had no impact on AMC received; however, mothers whose infants received AMC differed significantly in their activity budgets from mothers who were the sole care providers ( $p < 0.05$ ). Pilot data linking kinship and hormones to variation in AMC will also be discussed.

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#### **A case study on the multiple components of identity**

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Historically, the concept of “blood” as a symbolic proxy for ancestry has been a key element of defining political identity, as well as shaping social and ethnic identity. Now, in the Genomic Age, symbolic blood has been reconceptualized as a scientific truth which can be revealed or verified through genetic ancestry testing. Previous scholars have discussed the way identity has become essentialized as biological through both academic and public discourse on genetic ancestry. However, few scholars have examined the relationship between various narratives of ancestry and identity. This multi-generational, single family case study serves as a point of departure for these discussions. Genetic data on ancestry is examined in concert with oral family history, obtained through individual interviews, and document-based genealogical research. When compared, these biological, oral, and historical narratives invite a dialogue regarding how biological understandings of ancestry may conflict with or complement previous constructions of both personal and family identity. Based on this multi-component analysis, scholars who seek to understand genetic population histories should also consider non-biological narratives of individual, family, and community identity. Within the larger context of molecular anthropology research, this study brings to light how biological anthropology may privilege biomolecular understandings of identity and group membership over other socially constructed definitions, and what information is gained or lost as a consequence. This family-based analysis also provides insight into the larger-scale relationship between genetic population history narratives and oral or historical narratives.

#### Gaps in Chinese Paleoanthropology: A View from Guangxi

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The paleoanthropological records of many regions within China are still poorly known. Here, we report the findings of recent multidisciplinary field and laboratory research conducted on sites and materials in and around Daxin city in Guangxi, southern China. Daxin falls under Chongzuo city jurisdiction, an area that has recently come to international attention because of the discovery of an early Late Pleistocene partial hominin mandible from Zhirendong that has been tentatively assigned to early *Homo sapiens*. Our own research in the Daxin area includes excavations at the

Sanxieshan Locality 2 cave site which resulted in the discovery of two hominoid permanent teeth [one left lower molar (SX15) and one right upper molar (SX09)] that were found just below overlying travertine dated to ~300 ka by uranium series. We have yet to definitively assign the molars to tooth position and/or taxon, but preliminary elliptic fourier analysis suggests one tooth falls more closely to *Pongo* and the other to Middle Pleistocene *Homo*. Linear metric analysis of the two teeth suggests a substantial amount of overlap between various Middle Pleistocene hominins and *Pongo*. Additional analyses will reveal whether these assignments hold up. A second cave surveyed in Daxin is Baoxindong. A wide diversity of vertebrate faunas were surface surveyed in the cave. Given the degree of fossilization of the fossils, we hypothesize that they are probably younger than Sanxieshan and probably date to the Late Pleistocene. The implications of these findings from Daxin are discussed in their broader paleoanthropological context.

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#### Sacral orientation and its relationship to the sexual dimorphism of lumbar lordosis

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Sacral orientation is strongly linked to lumbar lordosis and recent studies have demonstrated that the lumbar spine is sexually dimorphic with women having greater lordosis than men. Given that the pelvis is well-established as sexually dimorphic, we hypothesized that differences in sacral orientation between men and women, similar to those seen in lumbar lordosis, exist. In addition, we assessed the effects of postural orientation on sex-differences in the lumbosacral spine.

We measured lumbar lordosis using lumbar angle (between L1 and S1 cranial endplates) and sacral orientation using sacral tilt (orientation of the sacrum relative to the horizontal plane; ‘posture-dependent’) and pelvic incidence (orientation of the sacrum relative to the acetabula; ‘posture-independent’). We retrospectively collected measures of sacral tilt, pelvic incidence, and lumbar angle from

radiographs of 200 adult subjects: 121 standing (48 women and 73 men), 75 supine (39 women and 36 men), and 4 unknown. We found that sex differences in lumbar lordosis and sacral orientation are dependent on postural orientation. Sacral tilt and lumbar angle are significantly greater in women than men when standing ( $p=0.027$  and  $p=0.001$ , respectively), but not when supine. As expected, pelvic incidence was not different between standing and supine individuals; however, surprisingly, it was also not different between women and men.

Sexual dimorphism in sacral orientation, then, appears to be primarily postural and this result, combined with the postural component inherent in lumbar lordosis, suggests that sexual dimorphism in lumbar lordosis is driven by differences that occur when individuals are in an upright posture.

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#### Preliminary analysis of the functional morphology of the douc langur scapulae

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Colobine monkeys primarily move through their arboreal environment quadrupedally. Douc langurs, (*Pygathrix spp.*), a member of colobinae, are regularly observed brachiating rather than moving quadrupedally at the Endangered Primate Rescue Center (EPRC). The EPRC is in Northern Vietnam and houses numerous species of colobine monkeys in addition to a few gibbon species. The enclosures at the EPRC are structurally similar for all their primates and are unlikely to be the causal factor for the unusual locomotor style exhibited by these colobine primates. Previous work has linked scapular morphology to forms of primate arboreal locomotion. We investigated the overall shape of *Pygathrix* scapulae to determine if their scapular shape resembled obligate brachiators (gibbons), rather than that of obligate arboreal quadrupeds (other cercopithecoids). Using a microscope, we recorded 17 landmark data on 15 different species of nonhuman primates ( $n = 36$ ) that fell within two categories of locomotor behavior: brachiator and arboreal quadruped. Preliminary results indicate there is no significant difference in scapular morphology [ $\text{Pr}( > F ) = 0.41077$ ,  $\text{Pr}(\text{phy}) = 0.6078$ ] between *Pygathrix* and other arboreal quadrupeds. This indicates that douc langurs are facultative suspensory primates and that their morphology does not accurately represent a major component of their locomotor repertoire.

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### Allometry and Tooth Shape of the Lower Deciduous M2 and Permanent M1

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Our previous study of permanent upper first and deciduous upper second molars showed strong discrimination between Neandertals and *Homo sapiens* and suggested a significant allometric component to these differences in Neandertals. Here we apply the same method to lower permanent first (LM1) and deciduous second molar (ldm2) shapes. Geometric morphometric analysis was used on oriented crown outlines. Our sample included 42 ldm2/LM1 pairs from the same individuals (30 from recent *H. sapiens* and 12 from fossil hominins), as well as 28 and 69 unpaired dm2 and M1s, respectively, from Early and Upper Paleolithic *H. sapiens* and Neandertals. Principal Components Analysis (PCA) indicates that while the ldm2 shapes of Neandertals and recent *H. sapiens* occupy opposite ends of the variation, the overlap in values is high. The shape of LM1 does not discriminate groups well: fossil and recent *H. sapiens* show a wide range of shape variation that completely overlaps with that of Neandertals. Interestingly (and in contrast to results of upper M1/dm2), the allometric trajectory from ldm2-LM1 morphospace for Neandertals and Recent and Upper Paleolithic *H. sapiens* is not parallel (34°;  $P=0.013$ ). Moreover, the lower dm2 and M1 shapes of the latter groups differ more than those of Early *H. sapiens* and Neandertals. This most likely reflects the retention of a primitive *Dryopithecus* pattern in ldm2 and LM1 of Neandertals and a more derived LM1 pattern in *H. sapiens*. These differences between upper and lower molars support other studies suggesting different levels of genetic control and integration between the jaws.

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### An evaluation of the relationship between Harris line and dental enamel hypoplasia development in an early Middle Ages skeletal sample from Northern France

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The study of stress indicators is an important means of reconstructing the health status of past human populations. Skeletal indications of non-specific stress such as dental enamel hypoplasia (DEH) and Harris lines (HL) have been repeatedly investigated in archaeological populations as well as modern populations, but little evidence has been able to pin point their specific etiologies, with little correlation between the two. This research will attempt to evaluate the existence of an association between dental enamel hypoplasia and Harris line development. Association will be based on two levels; first on the basis of the presence and absence of indicators and secondly on the time of formation. To evaluate the existence of an association between HL and DEH occurrence, the concordance of presence and absence of indicators and the association of age of individuals at the time of formation of HL and DEH is measured. This research additionally evaluates the frequency and occurrence of HL and DEH as a determinant of physiological stress within age categories. A selection of 24 sub adult skeletons (aged 6 months to 20 years) from the early Middle Ages are utilized for this study. Statistical analysis by Fisher's exact test indicates no significant association between the presence/absence of Harris lines and dental enamel hypoplasia in this sample ( $p=0.751$ ). Of the 14 individuals with tibias available, six (43%) correlated at least one Harris line to one enamel hypoplastic event based on age at formation.

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### Post-mortem processing and mass burials at Wilson Mound, Cahokia

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Wilson Mound, located between the Cahokia and East St Louis precincts, presents a unique context to examine early Mississippian (ca. AD 1100) mortuary processing and burial practices specifically in relation to secondary burial and mass burial events. Post-mortem processing of human remains at Wilson Mound includes intentional disarticulation of the body using sharp implements, as well as secondary interment following natural decomposition and disarticulation. Originally excavated in the 1950s by Preston Holder, burials in Wilson Mound represent a single burial event of an estimated 190 individuals interred in five primary burials and 43 bundle burials. This poster presents results of a recent reanalysis of these remains. Evidence for disarticulation, extended mortuary processing and natural decomposition, is presented. Data regarding post-mortem processing of human remains were obtained through comparative analysis of original

excavation maps and the sample of human remains collected for analysis. Of 190 individuals included in a single mass burial event, 185 reflect varying states of disarticulation and decomposition at the time of final interment. Of the human remains available for analysis, 58 adults (20 females, 15 males, and 23 unknown sex) and 2 children were identified. The findings from this reanalysis reveal new information about Mississippian mortuary practices highlighting similarities among contemporary mortuary mounds at Cahokia, East St. Louis, and St. Louis emphasizing a shared practice and manipulation of the dead.

### From the Illinois to the Nile Valley: The Bioarchaeology of Nubia Expedition

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Ancient Nubian mortuary traditions are known largely from monumental elite cemeteries such as Kerma, El-Kurru, and Meroe and the 1960s salvage excavations in Lower Nubia. More recent work in Upper Nubia, however, has revealed substantial regional variation. The Bioarchaeology of Nubia Expedition (BONE) in the Middle Nile Valley of northern Sudan parallels the holistic bioarchaeological perspective developed in the Lower Illinois River Valley, including a regional approach to mortuary behavior within a broad sociocultural and environmental context.

Assessment of habitation, rock art/gong, and cemetery sites from the Mesolithic through Christian periods in the BONE project area on the right (north) bank of the Nile River in the region of el-Ginefab illuminates the rich archaeological record of a previously uninvestigated landscape. Mortuary practices in this "hinterland" at the top of the Great Bend show similarities to "core" sites, but local practices suggest that temporal differences in grave architecture and treatment of the dead are not always as distinct over time. Grave goods indicate inclusion in far-flung exchange networks rather than isolation. Persistence of local traditions, spatial and social organization within and among cemeteries, and distinct identities marked in life (e.g., dental ablation) or death (e.g., burial with archery equipment) from the Kerma period (c. 2500-1500 BC) through Christian periods (c. AD 550-1400) illustrate new aspects of ancient Nubian identity and mortuary behavior. Fieldwork and the collection of Nubian skeletal remains and material culture formed since 2007 have provided field and research opportunities for students, including Kampsville alumni.

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**Genetic boundaries of the Chibchan speaking populations of Central America based on mitochondrial DNA control region analyses**

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This study investigated maternal genetic diversity and population structure in 323 participants from five lower Central American indigenous populations from Nicaragua (Rama) and Costa Rica (Huetar, Maléku, Chorotega, and Guaymi) using complete mtDNA hypervariable region sequence data. Previous studies stated that the genetic structure of the Chibchan-speaking populations that inhabit the Isthmo-Colombian area including northern Colombia, Panama, Costa Rica, Caribbean Nicaragua and portions of eastern Honduras, was likely shaped by relative geographical isolation since the Holocene, posterior fragmentation around 7,000 YBP and later adoption of sedentary lifestyles. However, an alternative hypothesis suggests absence of cultural and biological continuity and their distinctive genetic structure is due to Mesoamerica and South America demic diffusions across the Central American Isthmus. To test the hypothesis of Chibchan genetic segregation, we compared these mtDNA data with an additional 33 indigenous populations from Mesoamerica, Northern South America and the Caribbean Islands and calculated haplotypic diversity applying three different hierarchical levels (cultural area, linguistic affiliation, and geography) using AMOVA and SAMOVA. These analyses were combined with median-joining (MJ) networks, tests of selective neutrality and diversity, and multidimensional scaling (MDS). We demonstrate that the maternal genetic structure of Chibchan populations was segregated by culture ( $F_{ct} = 0.14$ ,  $P < 0.001$ ) and linguistic affiliation ( $F_{ct} = 0.12$ ,  $P < 0.001$ ) when compared with other Caribbean, North and South American population aggregations. MJ networks and MDS show interconnected phylogenies among Chibchan populations and genetic affinities circa 10,000 YBP.

**The phylogenetic position of *Proconsul* and the difficulty of dealing with stem taxa in the fossil record**

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There continues to be a lack of agreement concerning the precise phylogenetic placement of *Proconsul* despite the wealth of fossil material known and the extensiveness of its study. The difficulty in resolving the phylogenetic status of this important and well represented taxon is a consequence of its apparent basal position relative to crown catarrhines. This position complicates the inference of character polarities. This study tests three previously proposed hypotheses concerning the phylogenetic position of *Proconsul*: (1) *Proconsul* is a stem catarrhine; (2) *Proconsul* is a stem hominoid; and (3) *Proconsul* is a basal hominid, most closely related to extant great apes and humans. A phylogenetic analysis based on 715 characters drawn from the cranium, forelimb, pelvis and foot, and sampling a diversity of anthropoid taxa, offers no compelling support for a hominoid clade that includes *Proconsul*. *Proconsul* lacks key synapomorphies that are found throughout the skeleton of crown catarrhines, and the analysis provides a clear demonstration that individual small-scale structural-functional complexes are insufficient to confidently support or refute any of the proposed phylogenetic hypotheses. A follow up analysis that combines the phylogenetic results with a temporal dimension confirms that *Proconsul* falls very close to the divergence between stem cercopithecoids and the hominoid lineage. In addition to helping settle the enduring debate about the phylogenetic status of *Proconsul*, these results offer fresh insights into the early stages of hominoid evolution and demonstrate the importance of comprehensive phylogenetic analyses in helping to resolve the relationships of problematic stem taxa.

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**A method for assigning sex based on the size and shape of the upper and mid-face**

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In hominin fossil assemblages, beyond inferring that relatively large specimens are males and relatively small specimens are females, there is currently no quantitative method available to assign sex to early hominin crania. Recent advances in 3D data collection techniques allow more accurate quantification of cranial form and therefore afford the potential to assign sex using quantitative methods. We use data taken from 3D surface scans and newly-developed 3D patch placement techniques to test the hypothesis that upper- and mid-facial size and shape are reliable predictors of sex in extant hominoid taxa. Data were obtained from 3D surface scans of dentally mature *Homo sapiens*, *Pan troglodytes*, *Gorilla gorilla*, *Pongo pygmaeus* and *Hylobates lar* of

known sex. Discriminant functions analysis was performed with cross-validation. For the mid-face, shape data alone yielded  $\geq 80\%$  correct classification for the great apes, and  $\sim 60\%$  correct classification for *Homo sapiens* and *Hylobates lar*. Over 75% of great apes, and  $\sim 68\%$  of *Hylobates lar* were classified correctly using brow ridge shape data. Inclusion of size data into the analyses improved classification rates for the majority of taxa, where  $\sim 92\%$  of *Gorilla gorilla* and *Pongo pygmaeus* were classified correctly using data taken from the mid-face, and  $\sim 85\%$  of *Gorilla gorilla*, *Pongo pygmaeus* and *Hylobates lar* were classified correctly based on upper facial morphology. The high correct sex classification rates in great ape taxa using craniofacial shape data alone suggests that the quantification techniques developed here have the potential to accurately sex fossil specimens, regardless of taxon-specific sexual size dimorphism.

**Genetic influences on Health: Does race matter?**

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Race has been a rancorous issue for decades and there continues to be both national attention focused on race and misconceptions about the relationship between notions of race and biology. Race clearly fails to accurately account for the mixed ancestral origins of many Americans and the frequencies and effects of many risk alleles influencing health co-vary more closely with genetic ancestry than with race. Accordingly, it might seem intuitive to encourage health care providers to adopt an objective DNA-based assessment of ancestry instead of using racial categories to stratify disease risk and guide management decisions. Should we be concerned if DNA-based ancestry testing replaces popular notions of race as a risk variable in clinical practice? Using ancestry as risk factor has also been controversial because of the concern that emphasizing group differences could lead to further disparities in health, healthcare, and healthcare outcomes. Accordingly, there is interest in knowing whether ancestry inferences based on explicit genetic data have greater predictive value for estimating genetic risk of health-related phenotypes. Studies are underway to explore how best to make ancestry inferences, and what effect, if any, such inferences have on discovery of genetic risk variants or the predictive value of these variants. The results of these studies should provide important guidance to clinicians and policymakers. Yet, cheap and efficient whole-genome sequencing is rapidly becoming available and could make use of information about group membership largely obsolete.

### A.L. 333-105: Virtual reconstruction and 3D printing of *Australopithecus afarensis* child

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Afar Locality 333 site was discovered in 1975. The rich hillside site yielded more than 200 bone fragments representing at least 13 individuals. This fossil accumulation, considered to be a onetime catastrophic event, became known as the "first family" site. One of the interesting findings from this location is A.L. 333-105, a rare infant skull, aged 3-4 years. Although the skull is almost complete, some of the cranial bones are missing, while others are broken and taphonomically distorted. The purpose of this work is to virtually reconstruct the skull and print the complete corrected one.

A high quality plastic cast of A.L. 33-105 was CT scanned, and imported into Amira software. Bones were individually separated, while those missing were duplicated from the other side. We then proceeded to realign the maxilla and zygoma, creating a complete midface. The crushed frontal bone was fixed using geometric morphometric (GM) techniques and aligned to the midfacial skeleton. The temporal bones were remeshed by using the two fragments from both sides. The missing upper calvaria was created using GM methods based on the calvaria of infant chimpanzees. The final reconstructed skull was printed using a 3D printer.

Measurements of the complete skull are generally similar to those of the Dikika skull. Glabella–Opisthocranion is about 115mm and Prosthion–Opisthocranion is about 135mm. Endocranial volume is about 340cm<sup>3</sup>. Virtual reconstruction techniques are indeed extremely helpful and important, by increasing the sample size of the rare hominid fossil record.

### Differently Abled?: Africanisms, Disability, and Power in the Age of Atlantic Slavery

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Traditional religious beliefs and cultural practices among many West African ethnic groups suggest a logic that casts those considered "disabled" in Western worldviews as, instead, uniquely empowered. These beliefs resounded in the ethos, healing practices, and folklore of enslaved peoples throughout the New World, underscoring a facet of African cultural retentions – perceptions of the body and mind in relation to structures of power – that scholars

have long overlooked. According to Yoruba creation myths, for instance, the deity Obatala – who molds all living beings from clay – once drank too much palm wine and created humans who were blind, albino, and physically disabled. Ever since, people with these characteristics were known as *eni orisa*, "people of Obatala," and revered in his shrine. Among the Yoruba and Igbo, *abiku* and *ogbanje* children were likewise understood as possessing deep ties to the spirit world despite physical and psychological qualities that render them "disabled" in western contexts. Those living with dwarfism were also perceived as potent spiritual beings in many West African societies. In Yorubaland they were perceived as powerful beings that carry out the will of the gods. Among the Ga and Adangbe, those with cognitive impairments – historically understood in the West as "feebleminded" – were believed to be incarnations of divine beings and treated with great reverence. As these examples make clear, West Africans often traditionally understood those with extraordinary bodies and minds as spiritually empowered, a belief that echoed in profound ways among New World enslaved populations.

### Stereological analysis of age-related variation in the human superior temporal association cortex

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The association cortex of the superior temporal gyrus (STG) participates in complex social and linguistic functions. Accordingly, comparative evidence suggests it may be differentially enlarged in human brains relative to other primates. This region also exhibits a protracted period of cortical maturation through late childhood and adolescence, marked by a decrease in cortical thickness. This raises the question: how do human neural specializations arise through cellular development, especially in childhood, which has been proposed to be a human-specific developmental period? We began to address this question using stereological techniques to track the trajectories of cortical pyramidal neurons from childhood to adulthood. The homotypical isocortex of the STG, area TA, was identified in Nissl stained sections and the optical fractionator and nucleator, respectively, were used to estimate pyramidal neuron number and pyramidal somal and nuclear volume. In 11 cases aged 4-48 years, the average number of neurons was approximately 91 million. Age and neuron number were not correlated. In contrast, pyramidal somal and nuclear volume were both negatively correlated and linearly associated with age in regression analyses ( $p < 0.05$ ). Average somal volume for pre-pubescent cases ( $n=5$ ), 1,708  $\mu\text{m}^3$ , was significantly greater than post-pubescent cases ( $n=6$ ), 1,349  $\mu\text{m}^3$ , in a Mann-

Whitney U test. Overall, the data support the idea that postnatal neuron numbers are relatively stable through development, concordant with existing non-human mammalian data. However, variation in neuronal volume may be an important parameter associated with gross patterns of cortical maturation and synaptic refinement through human childhood and adolescence.

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### A method for analyzing complex joint surfaces in ecomorphology using slope rasters derived from Digital Elevation Models

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Ecomorphology aims to link morphology with functional role within an ecological context. The artiodactyl astragalus is a common target of ecomorphological study due to its frequent preservation in the fossil record. Functional hypotheses predict that the tibial trochlea of the astragalus of highly cursorial taxa in open habitats should have steeply sloping surfaces to prevent joint dislocation during rapid locomotion. The need for lateral joint stability is relaxed in taxa that rely instead on cypsis to avoid predators in more closed habitats. However, previous attempts to analyze the tibial trochlea using linear measurements have yielded mixed results.

We analyzed laser scans of 15 bovid (11 species) and three cervid astragali (two species). Models were oriented consistently, and the area corresponding to the tibial trochlea was extracted. A Digital Elevation Model raster was created and used to calculate the slope of each pixel on the surface. Values of the resulting slope raster were visualized with histograms.

Open country bovids typically show unimodal slope distributions, with a mode  $> 1$ , indicating more steeply sloping surfaces in accordance with functional predictions. Bovids from forest habitats typically evince multimodal slope distributions, with a greater distribution of pixels with slope values  $< 0.5$ . The three cervid specimens, including the highly cursorial *Rangifer*, show a multi-modal pattern similar to forest-adapted bovids. This finding emphasizes the importance of considering phylogenetic signal in ecomorphology. This method offers a novel way to characterize complex anatomical curvatures that can be applied to a wide range of research questions.



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**Adiponectin and fat soluble vitamins: A nutritional physiology and bio-demography study in four central Kansas Mennonite populations**

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Adiponectin, an adipocytokine released from adipose, regulates glucose and fat metabolism. Serum levels show inverse correlation to body fat, however, and low levels of adiponectin correlate with obesity, diabetes and cardiovascular disease. Recent research suggests that fat soluble vitamin D may be associated with variations in serum adiponectin levels. We examine these relationships in 160 individuals (75 males and 85 females) ages 22 to 90 in four Central Kansas Mennonite communities. Three-day dietary diaries were analyzed to determine nutrient profiles using NutriBase software. I examined fasting adiponectin and anthropometric measures. Vitamin D intake, log-adjusted fasting adiponectin levels, and standard anthropometrics measuring body fat were analyzed using ANOVA in SPSS 22.

Females ( $p=0.001$ ) showed variation in adjusted adiponectin levels among communities both before and after adjusting levels for age and anthropometrics. Males had an average BMI of 26.65% while females had an average BMI of 25.20%, male had an average waist-hip ratio of 0.91% and female had an average waist-hip ratio of 0.76%. The data shows women having higher average fasting serum adiponectin as compared to males in all locations, females from Goessel have the highest adiponectin levels, whereas females from Lone Tree have the highest dietary intake of vitamin D IU comparatively. Dietary vitamin D intake was not associated with variation in adiponectin levels. Heightened levels of adiponectin are associated with arterial stiffness. The relationship between plasma adiponectin and cardiovascular events remains inconclusive however. Further research is required to determine the role of adiponectin in cardiovascular disease by nutrition.

**Multiple instances of convergence in primate limb evolution**

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Previous work has emphasized the integrative aspects of the evolution of limb lengths, with a

possible higher level of evolvability in apes. We expanded previous datasets (to 179 fossil and extant primate species) and re-analyzed the data in an explicitly phylogenetic framework (using Ornstein Uhlenbeck model fitting to detect putative patterns of convergent evolution). Results indicate that the phylogenetic landscapes of within and between fore- and hind-limb evolution is best explained by multiple instances (>5) of convergence.

Contrary to previous work we find that apes (Hominoidea) do not indicate significantly reduced integration compared to other primates, but rather that different apes converge with different groups of other primates for different limb indices. For example, for the brachial index *Nomascus* and *Symphalangus* converge with *Pongo*, *Ateles* and non-indriidae strepsirrhines; *Hylobates* converge with indriidae; and *Pan* converges with *Alouatta*, *Lagothrix*, Aotidae, Cebinae, and Saimiriinae.

We conclude that the evolution of limb lengths and limb segment proportions exhibits a higher degree of evolvability than previously reported, challenging our understanding of the relationship between development, quantitative genetics and evolvability.

**Gibbon density in western Thailand: The influence of altitude and forest type**

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The Huai Kha Khaeng Wildlife Sanctuary (HKK) in western Thailand is remarkable for the fact that evergreen, mixed deciduous, and deciduous dipterocarp forest (DDF) occur within only a few hundred meters of each other across a range of altitudes. To explore the relationship between forest type and gibbon group density we conducted vocal surveys of gibbons (*Hylobates lar*) from February 2012–August 2013. We predicted that there would be a negative correlation between gibbon density and DDF, due to fruit scarcity.

We established 31 pairs of listening posts along main roads throughout the sanctuary and over 3–5 days/post recorded the total number of great calls detected and estimated the number of distinct groups heard/day. We used *Distance 6.0* to calculate gibbon density and the effective detection radius (EDR). Within each listening area ( $A=\pi\text{EDR}^2$ ) we calculated the percent of DDF based on satellite imagery. Mean altitude for each listening area was derived by superimposing a 100m grid and averaging the altitude of all grid intersections.

The EDR across all posts was 862m and the combined density was 2.9 groups/km<sup>2</sup>. Contrary to expectations there was no correlation between forest type and gibbon density ( $p>0.05$ ), though there was a significantly positive correlation with altitude ( $r=0.60$ ,  $n=31$ ,  $p<0.001$ ). These findings may indicate that gibbons occupying areas with high amounts of DDF are able to compensate for low fruit abundance by switching to alternative resources such as flowers or insects, which would have important implications for gibbon conservation. The role of altitude is also discussed.

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**Geometric morphometric analysis and internal structure measurements of Neanderthal and modern human lower second premolars**

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In the past years two-dimensional (2D) and three-dimensional (3D) computer-based methods have been used to discriminate Neanderthal (NEA) and recent *Homo sapiens* teeth (RHS). Nonetheless, most of the studies have focused on molars and anterior teeth, and few contributions have explored the premolars. In this study we present an analysis of lower second premolars using geometric morphometric methods on oriented crown outlines and several internal parameters of the crown. Our sample consists of 58 individuals in total, including 9 NEA (from Croatia, France and Germany), and 49 RHS specimens ranging from the Neolithic to present time (from Europe, North Africa, Sub-Saharan Africa, Asia and Oceania). The microCT images of each specimen were virtually segmented, and 16 2D-pseudolandmarks were digitized along the crown outline of the 3D models (as seen in occlusal view). Additionally, the following measurements were considered: the height of the crown (CH), the dentine volume including the pulp chamber (LDPV), and the contact surface area between the dentine and the enamel cap (EDJ). Principal Components Analysis (PCA) of the outlines separates NEA from RHS. Moreover, while there is large variance in CH for both taxa, the data collected on the EDJ proved to be a relatively reliable measurement for a distinction between NEA and RHS. Finally, LDPV data showed a clear distinction between the two species. A combination of all the data used in our approach

provides an important tool and database for the taxonomic investigation of fossil remains.

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#### **Oral Health of the Middle and Late Woodland in the Mississippi River Valley of Illinois**

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Oral health markers were compared were compared between two osteological samples from the Mississippi River Valley of northern and central Illinois: Albany Mounds (Middle Woodland, approximately 200 BC – AD 400) and Kuhlman Mounds (Late Woodland, approximately AD 500-800). These included the prevalence of caries, antemortem tooth loss, abscessing, calculus, and periodontal disease in each sample. Given the presumptive shift in subsistence strategy between the two temporal periods, a marked difference in the prevalence of each of these oral health markers, especially caries frequency and location (i.e., occlusal versus cervical) was expected between the samples. However, the results indicate that few individuals display caries at all (approximately 2.38% prevalence at Albany Mounds and 2.28% at Kuhlman Mounds). Similarly, the two sites have approximately the same number of abscesses, (53 at Albany Mounds and 60 at Kuhlman Mounds), as well as number of teeth lost antemortem, (145 at Albany Mounds and 102 at Kuhlman Mounds), the number of alveoli displaying periodontal disease (910 at Albany Mounds and 1073 at Kuhlman Mounds). Finally, the frequency of heavy calculus between the two sites was similar (13.10% of teeth were affected at Albany Mounds and 16.62% affected at Kuhlman Mounds). The observed inter-site similarity is hypothesized to be because neither sample dated to the adoption of flint corn in the area (circa 900 AD), which resulted in a greater dietary reliance on maize. Further research is needed to test the effects of additional food sources on oral health.

#### **Differences in energy metabolism in the brains of humans and chimpanzees: a study of protein expression**

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Although the adult human brain requires 20% of the body's resting glucose metabolism, no other primate allocates more than 10% of their energy to their brain. However, it is unknown if humans appropriate energy differently across the many neuronal types that compose the neocortex and other brain areas. We performed high-throughput mass spectrometry at high spatial resolution from individual regions (anterior cingulate and primary motor, sensory, and visual cortices) and layers of the neocortex (layers III, IV, and V) and cerebellum (granule cell layer), as well as the caudate nucleus in humans and chimpanzees. A total of 39 proteins were quantified in both species, including 14 that support aerobic metabolism. We explored how the pattern of protein expression varies across regions and cortical layers to provide insights into the energy use of these neural structures between species. Overall, the expression of proteins differed principally in a region- and layer-specific pattern, with subtle differences between species. While human and chimpanzee brains were generally similar in their distribution of proteins related to regulatory functions, they differed more markedly in their expression of proteins supporting aerobic metabolism. In both species, layer III of the neocortex expressed particularly high levels of proteins supporting aerobic metabolism compared to other cortical layers, suggesting that the connectivity within the cerebral hemisphere may be enhanced in both species. This work extends current understanding of energy allocation in the brain that may underlie human cognitive specializations by providing a novel perspective of the molecular phenotype.

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#### **A Transparent Method for Sex Estimation Using Refined DSP Measurements of the Innominate**

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Methods used in bioarchaeology and forensic anthropology need to be validated to test their utility on a variety of samples. DSP (Diagnose Sexuelle Probabiliste; Murail et al. 2005), a recent promising method for estimating sex very accurately, analyzed over 2,000 individuals from different continents using previously published innominate measurements from several sources. DSP had the ingredients of a valuable modern method in providing a computer program (a spreadsheet), and measurement descriptions and photographs (in the spreadsheet). Though DSP was recently independently validated using CT data (Chapman et al. 2014) and showed high accuracies, the original method is essentially a black box: their spreadsheet is protected, with no access to the actual logistic regression equations applied to the data. Their publication did not include group means, equations, or intra- or inter-observer errors, or specify that the classification accuracies were cross-validated, and included the questionable recommendation that only individuals with very high posterior probabilities (> 0.95) be classified. Further, their spreadsheet has not been available anywhere online for at least six months, making this method unsuitable for use.

In order to investigate the potential of innominate measurements for sex estimation transparently, our study used eleven refined DSP measurements on innominates from individuals born in the 19<sup>th</sup>- and 20<sup>th</sup>-centuries and from recent high quality CT scans. Most of the measurements showed very low interobserver differences. Classification accuracies were over 96% and showed very low levels of classification bias by ancestry. Subsets of these eleven measurements were also highly accurate.

#### **New discoveries of fossil tarsiform primates and their implications for anthropoid origins**

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Tarsiers are perhaps the most anatomically autapomorphic of all living primates. Having lots of apomorphies should simplify the task of recognizing fossil relatives of tarsiers. Indeed, a few Eocene and Miocene fossils from China, Thailand, and Pakistan share convincing apomorphies with tarsiers, indicating that Tarsiidae have been present in Asia since ~45 Ma and that their current distribution is relictual. A broader assemblage of Eocene primates, usually called omomyids or omomyiforms, is also frequently cited as being closely related to tarsiers, following William King Gregory's notion of Tarsiiformes. Recent paleontological discoveries show that Omomyidae is at least paraphyletic, with taxa such as *Shoshonius* from

the early Eocene of Wyoming being very closely related to tarsiers while other omomyids (notably including *Omomys* itself) are more distantly related to them. The problem of omomyid paraphyly has been exacerbated by the recent discovery of *Archicebus achilles* from the early Eocene of China. *Archicebus* was a tiny (20-30 g), anatomically primitive haplorhine with relatively small orbits, no postorbital septum, four premolars in each jaw quadrant, and short tarsal bones. If *Archicebus* shares a special relationship with tarsiers, then the common ancestors of tarsiers and anthropoids were far more primitive than previously imagined, and they would not have been "tarsier-like" in any meaningful way. Fragmentary fossils from Afro-Arabia have sometimes been assigned to Tarsiiformes, but these taxa are more likely to be eosimiiform anthropoids. There is no convincing evidence that tarsiiformes ever inhabited Afro-Arabia; hence cladogenesis between tarsiiformes and anthropoids must have occurred in Asia.

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**Miombo woodlands and early hominins: A comparison of carbonate stable isotope data from modern Koobi Fora and 3.97Ma Allia Bay fauna**

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The ecological niche exploited by early hominins is assumed to have played an essential role in the origins of bipedalism, a distinguishing characteristic of hominins. Reconstructing the paleoenvironment at early hominin sites is essential for understanding the selective forces that resulted in such a significant morphological change. This study focuses on Allia Bay, Kenya (site 261-1, 3.97 Ma) where *Australopithecus anamensis*, the earliest obligate biped, is found associated with fossil hippos, elephants, giraffes, suids, deinotheres, and bovines. An early pilot study (Schoeninger et al., 2003, JAA 22:200-207) suggested that the region was more mesic than today with an environment similar to modern miombo woodlands. Here we present new bulk stable carbon and oxygen isotope data of tooth enamel of 50 fossil fauna from Allia Bay and bone carbonate from 156 modern fauna collected within the larger Koobi Fora basin. After applying correction factors (i.e., Suess effect, converting bone to enamel values), the fossil fauna have lower oxygen values and lower carbon isotope values compared to the modern fauna. The carbon isotope data may indicate minor diagenetic alteration (Schoeninger et al., 2003, IJO, 13:11-19), which we are currently investigating further with new analytical techniques. The oxygen isotope data indicate a wetter paleoenvironment with more tree cover compared to the modern Koobi Fora basin. Our results support the proposal that selection for bipedalism in *Au. anamensis* originated in an environment similar to modern miombo

woodlands, which are wetter than the modern day Koobi Fora basin.

**Migration and Expansion: Maternal Markers of the Garifuna**

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Mitochondrial DNA has been used to provide a maternal side of history, and to better understand populations in expansion. The Garifuna provide an example of this use. The Garifuna originated on the island of St. Vincent following an admixture event between survivors of a wrecked slave ship and native populations. Over a hundred years later, 2,500 Garifuna were forcibly removed from St. Vincent by the British in 1797, and placed on the island of Roátan. As the population expanded, the Garifuna spread to the coast of Honduras, and later to over 54 villages along the coast of Central America. Today, some estimates suggest that there are over 100,000 Garifuna living in Central America. This study compared the mtDNA lineages of participants from Roátan, and three settlements on the Honduran coast: Cristales, Rio Negro and Santa Fe. MtDNA was examined using sequence and RFLPs data. Two patterns emerged. First, African lineages make up the majority of lineages found in the Garifuna, but frequencies vary within communities. For example, the communities of Cristales and Rio Negro are both located in Trujillo, Honduras, but the frequency of haplogroups L0-L2 are 62% and 80% respectively. Second, haplotypes that are shared between the Garifuna villages are usually of African origin, belonging to haplogroup L0, L1, L2 and L3, whereas native haplotypes A and C were not shared between villages. However, when shared, haplotypes are found in only one other community, consistent with a matrilineal system that divides along maternal lines.

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**A dental approach to salvage excavated and commingled burials**

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Bioarchaeologists working with salvage-excavated collections are faced with a unique suite of issues that include limited provenience information, poor spatial control, and post-

excavation commingling of remains. Because human teeth survive the rigors of the archaeological record and provide data about MNI, age, diet, and health, dental analysis offers one method of untangling the tortuous history of a salvage-excavated collection. Marroquies Bajos, a 113-hectare Copper Age enclosure site, is well known within Iberian archaeology due to the rich grave furnishings recovered from the necropolis of Marroquies Altos in the 1950s. However, this artificial cave burial has been excavated multiple times since that decade, and due to the extreme commingling of remains has not been subject to previous bioarchaeological analysis. To untangle the mortuary practices in use at Marroquies Altos, I (1) use models drawn from forensic taphonomy to outline expected patterns of dental preservation for different burial practices, and (2) compare the new data from Marroquies Altos to data collected from two other well-documented and previously unstudied mortuary areas at Marroquies Bajos, one of primary burial (Necropolis 1) and one of secondary burial (Necropolis 2). Chi-square tests and ANOVA reveal significant differences in the categories of teeth preserved in each area, as well as differences in the ratio of adult to non-adult dentition recovered from each locale. This study also explores variability in the frequency of hypoplasias, caries, and calculus severity over these three mortuary areas, highlighting variation in dental health between individuals buried in this Copper Age community.

**Impacts of the number and types of teeth employed in assessing developmental ages from skeletal samples**

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Assessing developmental age is the first step in ontogenetic studies of skeletal remains. Many skeletal regions provide aging data, but for the fetal-young adult age range the dentition is the most accurate. Numerous studies provide methods for assessing developmental ages from teeth but vary in the number/types of teeth assessed and whether they include eruption data. We hypothesize that these varying methods have the potential to impact the range of variation exhibited in age groups and to create non-comparable samples.

To test this hypothesis we CT-scanned a dry skull sample (n=56). The dentition was evaluated via construction of isosurfaces and volume-



texture renderings. Individual ages were calculated as averages of the degree of calcification per tooth; eruption was not assessed (range 4.7-9.1y). We then created age groups using various combinations of teeth and assessed changes in the statistical output for 93 cranial dimensions. We also examined the impact of these groupings on sample configuration in morphospace using Morphologika.

Age estimates varied between the upper and lower dentitions (-0.9-1.4y). Following studies that use only lower molars for aging resulted in a -0.6-0.8 year difference from the averaged age. Comparisons of a range of differentially aged groups to the original sample showed significant changes in the summary statistics for the dimensional series as well as substantial shifts between age groups in morphospace. These results demonstrate that caution should be exercised in compiling results from studies employing different aging methods or studies comparing individuals aged from partial dentitions to those aged with complete dentitions.

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#### **Physical anthropology and evolution education research: Exploring physical anthropology students' evolutionary reasoning**

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Biology students are the subjects of the vast majority of a growing body of evolution education research concerning student understanding of evolution. Physical anthropology (p.a.) applies evolutionary theory as an organizing framework, but is situated within the context of human evolution. This study tests the hypothesis that the context of human evolution provides certain cognitive advantages in evolution education, by investigating p.a. and biology students' evolution understanding. A survey assessing student understanding of evolution was used to collect data on introductory biology (n=125) and p.a. (n=85) students from a Midwestern university, both directly following evolution instruction and at semester's end. Explanations of evolutionary change were scored for the presence of three key concepts considered necessary and sufficient for explaining evolutionary change (variation, heritability, differential reproduction). A chi-square analysis found biology students used these three concepts in tandem more than expected when asked to explain an increase in brain size (p=0.000), but there were no differences between courses for the explanations of change for the remaining three traits. A

pairwise comparison from a generalized linear mixed model revealed that p.a. students were more likely to use key concepts in questions asking about trait loss (p=0.044) compared to biology students directly following instruction, but these differences were not present towards the end of the semester suggesting that p.a. instruction may offer an advantage, but the information is not being retained. These findings have important implications for p.a. instruction and highlight the valuable role p.a. has to play in evolution education.

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#### **Sexual dimorphism and taxonomic diversity in hominine femora from the Miocene of Europe**

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Four well preserved hominine (African apes and humans) femora are known from the middle/late Miocene of Europe. Two are from the Vallès-Penedès basin (Catalonia) and two are from Rudabánya (Hungary). They are attributed to *Dryopithecus*, *Hispanopithecus* and *Rudapithecus*, although the distinction between the latter two is debated. The Rudabánya femora are from the same deposit, in which only one great ape is known. Body mass estimates match those from craniodental remains and clearly indicate that they belong to a male and a female *Rudapithecus*. Both femora from the Vallès-Penedès are male. Body mass estimates from the Rudabánya femora (20-23 and 40-45 kg) indicate a level of sexual dimorphism as in living *Gorilla* and *Pongo*. Femoral body mass estimates for *Hispanopithecus* range between 34-40 kg and 40-45 for cf. *Dryopithecus*. Metric and qualitative observations reveal significant differences in morphology between the sexes at Rudabánya and between the Catalan and Hungarian femora. These correspond to differences in other postcranial elements (phalanges, carpals) and the crania between the Catalan and Hungarian samples, suggesting that the genus present in Hungary differs from those present in Catalonia. Body mass dimorphism at Rudabánya is accompanied by strong canine dimorphism. While the pattern of social organization suggested by this dimorphism is unclear, it was probably different from that of less dimorphic extant taxa such as chimpanzees. This is consistent with the view that reduction in canine and possibly body mass sexual dimorphism in *Pan* and hominins is a shared derived character.

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#### **Differences in life history strategies in bonobos and chimpanzees: evidence from age-related changes in urinary testosterone levels**

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Developmental changes such as reproductive maturation are induced by a number of endocrine processes. For the onset of puberty in human and non-human primates, age-related changes in testosterone excretion are an indirect marker. While endocrinological changes during puberty are well investigated for male chimpanzees, less is known about puberty in female chimpanzees and bonobos. We investigated patterns of urinary testosterone levels in both sexes using urine samples from bonobos and chimpanzees to determine the onset of puberty. We found that older individuals of both sexes had significantly higher urinary testosterone levels than younger individuals, indicating that bonobos and chimpanzees experience juvenile pause, thereby following the general mammalian pattern. In males of both species, urinary testosterone levels increased around eight years of age and were comparable whereas in female bonobos, the increase occurred about three years earlier than in female chimpanzees. The study shows that urinary testosterone levels are a useful marker to detect the onset of puberty in both sexes in chimpanzees and bonobos. In males, age-related changes in urinary testosterone appear to be independent of species differences in aggression and mate competition seen in adolescents and adults. The finding that urinary testosterone levels rise earlier in female bonobos than in chimpanzees corresponds with an earlier time of first dispersal and suggests female bonobos may reach puberty at a younger age than female chimpanzees.

#### **Joint network modeling: Describing interdependence across behavioral networks to elucidate social stability**

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Stability in social systems is an emergent property that arises from the synergistic interaction amongst multiple components of the system. Although a variety of mechanisms of stability have been studied, the underlying social dynamics of stability remain poorly understood. We used a joint network modeling approach to

describe the interdependence between two behavioral networks (status signaling and aggression) across seven captive groups of rhesus macaques (four stable, three unstable) to characterize the underlying social dynamics of stability versus instability. Across all stable groups, the primary source of interdependence between aggression and status networks came from more frequent dyads than expected with opposite direction status-aggression (i.e. aggression goes from A to B, signals of subordination go from B to A). In contrast, such opposite direction aggression-status dyads decreased during unstable time periods (but remained higher than expected). Unstable groups also showed more frequent than expected dyads with ambiguous/contested dominance relationships (e.g. bidirectional aggression with either no status signals or bidirectional status). Thus, all stable groups showed the same joint relationship between aggression and status networks which was readily distinguishable from those during unstable periods. Given that any social or biological system can be represented by multiple behavioral, physiological, and/or ecological networks, this joint network modeling approach has broad applicability, and offers a new method of realistically and holistically extracting the dynamic processes involved in the emergence of social stability and complexity.

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**Direct Digital Radiographic Imaging of Archaeological Skeletal Assemblages: An advantageous technique and the use of the images as a research resource**

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The application of radiography to archaeological skeletal assemblages has often been limited with constraints of access to equipment & facilities for wet film radiography processing, time and financial costs. Direct Digital Radiography (DDR) is a method of radiography that provides a rapid and relatively inexpensive means for visualising and analysing the internal structure of skeletal elements, providing a valuable additional level of pathology data and in depth interpretation of archaeological skeletal assemblages. Important features of the technique are that it is non-destructive, mobile and being digital, can produce large data sets of images in a short time in multiple formats compatible with many online platforms. Based upon the results of research using digital radiographic images taken of a selected number of curated skeletal remains from the Museum of London, St Bride's Church and Worcester Royal Infirmary this presentation will demonstrate the advantages of DDR application to archaeological skeletal remains.

Highlighted will be the importance of working with radiologists & the clinical base of orthopaedic knowledge in diagnosing and understanding pathology; development of a valuable research resource for access by a wider audience and the impact to palaeopathology for a greater understanding of disease processes. Established clinical standard frameworks, DICOM and PACS, can be easily applied for use in the anthropological field. Following such existing systems for accessing, transferring, storing and sharing digital radiographic images between institutions, provide a means to address a curatorial issue necessary to face in regard to long term digital curation of such research resources.

**Cannibalism vs funerary defleshing and disarticulation after a period of decay: a comparison of modifications on human remains from four prehistoric sites**

SILVIA M. BELLO and ROSALIND WALLDUCK. Department of Earth Sciences, The Natural History Museum, London, UK.

Distinguishing cannibalism from ritualistic practices involving defleshing and disarticulation of a body without consumption of any human tissue (such as secondary burial and trophy taking) commonly relies on the analysis of skeletal element representation and the identification of bone modifications (cut marks, bone breakage patterns, human tooth marks, cooking traces). It has been suggested that cannibalism can only be demonstrated when the archaeological context and bone modifications can be directly linked to nutritional exploitation of the body. We present here a comparison between a human bone assemblage interpreted as cannibalism (Gough's Cave, UK; Upper Palaeolithic, ~14,700 cal BP) and three assemblages of disarticulated human bones interpreted as funerary defleshing and disarticulation after a period of decay (Padina, Vlasac, and Lepenski Vir, Serbia; Mesolithic-Neolithic, ~9,500–5,500 BC). Results have shown that the distribution of cut-marks is comparable in the four assemblages and can equally be associated with disarticulation, defleshing, skinning and fileting of the muscle mass. The difference in the frequency of modification, however, is highly significant. The frequency of cut marks at Gough's Cave exceeds 65%, while it is below 1% in the Serbian sites, and no percussion or human tooth marks have been observed on the three Serbian collections. Results suggest that a higher frequency of bone modification is compelling evidence for processing of the human body during cannibalism.

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**Intergroup variation in estrogenic plant consumption for the black-and-white colobus monkey of Kibale National Park, Uganda**

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Alterations in diet have occurred throughout the evolutionary history of primates, including the *Homo* lineage. Currently, a distinct change in the modern human diet is occurring with an increase of soy consumption in many parts of the world. However, the physiological and behavioral implications of this change are unclear. Soy possesses phytoestrogens, which are estrogen mimics that are known to have effects on reproductive physiology and behavior in vertebrates, but effects on wild primates are not well understood. We observed the behavioral activities of eight black-and-white colobus monkey troops (*Colobus guereza*) living in Kibale National Park, Uganda, for one year, with a focus on dietary strategies. We analyzed staple plant foods of the monkeys to determine estrogenic activity using transient transfection assays and examined intergroup variation in the consumption of estrogenic plants across the eight groups. The percent of diet coming from these estrogenic plant items varied from 1.5% to 6.2%. To test for behavioral effects of phytoestrogen consumption, we examined the relationship between percent of diet from estrogenic plants and percent of time spent grooming and self-grooming, with no significant trends detected. As effects of estrogenic plant consumption occur at the individual level, future research will examine changes in hormone levels before and after consumption of the identified estrogenic plant items. By further examining variation in phytoestrogen consumption both within and across primate species, we hope to clarify the role of these estrogenic compounds in the evolutionary history of modern humans.

**Testosterone Mediates Loud Call Production in Gelada Males**

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Many animals rely on information from vocal signals to assess potential competitors and attract



mates. Vocalizations may function as honest indicators of male condition when either the mode of delivery (e.g. display) or the acoustic properties of the call are costly to produce. In birds and anurans, testosterone influences call production through its effects on stamina and vocal musculature. Testosterone is also associated with physiological costs, such as reduced immune function, that constrains signal development. Despite the effect of testosterone on calls in these taxa, little is known about the relationship between testosterone and vocal displays in non-human primates. Here, we examine the influence of testosterone on loud call production in a wild primate, geladas. In geladas, harem-holding males give loud calls during chase displays with bachelor males, presumably as a show of condition. If these displays are testosterone-dependent, we expect that only males with high androgen levels will possess the vocal musculature to produce specific acoustic features and/or the stamina required for repeated displays. To test this we conducted a cross-sectional and longitudinal study combining behavioral, acoustic, and fecal hormone analysis on 32 gelada males. As predicted, we found that males with high mean testosterone levels engaged more in loud call displays and had acoustically distinct calls than males with low circulating testosterone. Moreover, we found a direct relationship between seasonal differences in testosterone and display rates, with males calling more during the months in which testosterone was highest (wet season).

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#### **An efficient novel technique for genotyping MHC-DRB exon 2 in primates**

CHRISTINA M. BERGEY. Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

The Major Histocompatibility Complex (MHC) contains numerous genes that are essential to the immune system and are some of the most diverse in the human genome. Variation at these genes is biomedically important due to their association with pathogen susceptibility, autoimmune diseases, organ and stem cell rejection, and maternal-fetal histoincompatibility; and MHC loci are known to influence mate choice in some taxa. These connections to disease risk and sexual selection have encouraged the study of MHC in non-human primates, both captive and wild. However, prior to the adoption of massively parallel sequencing technology, methods for genotyping MHC loci have been time consuming and labor intensive. Building on recent methods, I have created a novel technique for library preparation for the Illumina platform to sequence a portion of the MHC-DRB exon 2 in primates. The technique allows the efficient multiplexing of hundreds of individuals, and, in a single PCR step, incorporates self-correcting

dual indexed barcodes to identify individuals and "heterogeneity spacers" to avoid low complexity libraries. Alongside the technique, I have released a program to design indexed adaptors with custom priming sequences for the amplification of other MHC loci.

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#### **From inner ear to lifestyle : paleobiology of a fossil primate from Eocene**

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European adapines, and especially *Adapis parisiensis*, have been intensely studied during the two last centuries, essentially for taxonomic and phylogenetic purposes. Analyses of dental, cranial and also post cranial morphology have led to various hypotheses on the diet, locomotion and lifestyle of this fossil primate species. However, the morphology of *Adapis* is not directly comparable to any one of extant species, and so some interpretations are still a matter of debate. The inner ear is crucial to several functional parameters, such as auditory acuity, balance, agility, orientation and speed motion of the head in locomotion. We examined the *Adapis parisiensis* inner ear morphology in order to make some functional inferences, using  $\mu$ CT techniques to access the internal morphology without damaging the fossil specimens. We analyzed the length and shape of the cochlea, the size of the oval fenestrae and the size and orientation of the semicircular canals of five skulls of *Adapis parisiensis*. Results indicate that the species was more sensitive to high frequencies than to low ones. They also indicate that the style of locomotion was probably quicker than proposed by previous studies. We also found a level of metric variation in the estimation of several parameters which may indicate different behavioral patterns among individuals within the species. Our results are also discussed in terms of systematics, paleobiology and paleoenvironment.

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#### **Hominoid dental topography: a possible case for character displacement**

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Dental topography has proved to be a powerful tool in reconstructing mammalian diet from

postcanine tooth shape. In extant primates, species with more fibrous diets tend to have higher dental topographic values than species with less fibrous diets. Despite this correlation, there is no deterministic relationship between dental topographic values and dietary categories, e.g. platyrrhines have higher RFI and OPCR scores for a given dietary category than prosimians. Therefore, when reconstructing diet, it is important to compare extinct mammals to their extant relatives. Here, I computed one measure of dental topography, Dirichlet normal energy (DNE), on 61 hominoid molars in order to produce a reference dataset for the hominids. In general, folivorous apes (*Gorilla beringei beringei*, *G.b.graueri*) had higher DNE scores than frugivorous apes (*Pan paniscus*, *P. troglodytes troglodytes*, *P.t.schweinfurthii*, *Pongo pygmaeus*, *G.gorilla gorilla*), but the difference was not statistically significant. Interestingly, gorillas that live sympatrically with chimpanzees had significantly higher scores than those chimpanzees, and *G.b.beringei* had similar scores to *G.g.gorilla* and *P.t.schweinfurthii*, implying character displacement may be acting on molar shape in hominoids. In addition, contrary to previous studies, subspecies of apes (*P.t.schweinfurthii* and *P.t.troglodytes*, *G.b.beringei* and *G.b.graueri*) had significantly different scores, illustrating the need to differentiate hominoids on the subspecies level when doing tooth shapes analyses. Results of this study further suggest that dental topography cannot be used to assign hominids to dietary categories, but can be used to compare sympatric species of hominids in order to determine which had more fibrous diets.

#### **Front lines and cementum lines. An attempt to identification of soldiers from the World War I using cementochronology**

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Cementochronology, that involves the counting of incremental lines in tooth root cementum, is considered by most of the studies as an accurate and precise method to estimate age-at-death. Yet, despite the superior performance of this technique, the overall inaccuracy, even low, makes disputable the use of the cementochronological age as a criteria for positive identification of a body. This work aims, in a singular context, to discuss the potential of cemental annulations for a positive identification by process of elimination. We applied a protocol certified according to the ISO-9001 to twenty-one German soldiers discovered in the Kilianstollen, a perfectly preserved World War I

tunnel (Carspach - Alsace, France). The combatants were part of the German Army's 94th Reserve Infantry Regiment and were buried alive on March 18, 1918 after a French bombardment. All individuals were identified with help of dog tags, pay books and a memorial tablet. Even if all names were known, a doubt subsisted for the identification of three bodies. Cementum lines counting on histological micrographs was done manually in Adobe® Photoshop and with an automated module on the Visilog® platform to eliminate factors such as subjectivity and to reduce intra/inter-observers errors. Results demonstrated that the accuracy of cementochronological age is notable and that the precision of computerized estimates narrows down the range of age estimation. Despite tight civil ages of the three young soldiers with suspicions of identity, cementochronology was able to support a positive identification through inter-individual relative assessments.

**Distinguishing impairment from disability in the bioarchaeological record: An example from DeArmond mound (40RE12) in east Tennessee**

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Bioarchaeologists have begun to pay special attention to questions related to numerous forms of social identity. Among these, concepts of impairment and disability have been described as the least-established in this area of specialized bioarchaeological scholarship. While this has historically been the case, recently scholars have developed models which define and differentiate impairment from disability. Moreover, concepts of care-giving have been refined and scholars can now to develop an index of care to further interpret bioarchaeological contexts where these questions may arise.

We contribute to this discussion by presenting a rare example of a cartilaginous dysplasia presented in a middle-aged or old adult female dated to the Mississippian period (A.D. 900–1600) excavated from the DeArmond Mound in East Tennessee. The right humerus and left femur of Burial 50 were 82mm and 58mm shorter than their counterparts, respectively. Such a discrepancy in limb lengths also resulted in the secondary presentation of Osgood-Schlatter's disease of both tibiae. These osteological data leave no doubt that this woman would have experienced notable impairment of her mobility. Despite these physical challenges, Burial 50 was afforded mortuary treatment no different than many other members of her community. This is in contrast to the mortuary treatment of other contemporaneous Mississippian individuals with physical impairments. We utilize the contrasts in these

mortuary data to draw attention to the concepts of impairment and disability in the bioarchaeological record.

**Water and Wellness: Irrigation, Water Resources, and Growth in the Ethiopian Highlands**

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Based on the prevalence of stunting and wasting, it is estimated that more than half of Ethiopian children under five are malnourished. Stunting is often associated with increased risk of mortality and morbidity as well as poor cognitive development. Childhood under-nutrition, therefore, is one of the most important public health problems in Ethiopia. Furthermore, growth failure due to infant and early childhood malnutrition can lead to shorter stature in adulthood, including adverse pregnancy outcomes and forming a vicious cycle. The aim of this study is to estimate the magnitude of malnutrition and investigate the relationship between malnutrition and various predisposing factors, such as socioeconomic, environmental, biological and cultural practices in two drought prone areas in Ethiopia.

A cross-sectional study, including a household survey and anthropometric measurements, was conducted on 1143 individuals from five districts in South Wollo and East Hararge Zones in Ethiopia between June and August 2011. The survey included demographic, socioeconomic, including land holdings, farming practices, access to irrigation, environmental hygiene and sanitation, types and frequency of diet, breast feeding and other relevant practices.

Bivariate and multivariate analyses, conducted to identify the determinants of stunting among under five children, demonstrate that multiple factors influence childhood stunting and wasting and are therefore responsible for malnutrition. Significant among these are access to safe drinking water and use of irrigation; both are associated with reduced prevalence of severe malnutrition in the highland study areas.

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Analysis of Native American Scalping From The Chavez Population

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Scalping, which is observed as cut-marks in the form of a rough circle on the superior aspect of the cranium of the individual, has been practiced by Native Americans since pre-Columbian times in North America. For this study, there are 7 crania with cut-marks evident of scalping from the Southwest population of Chavez Pass. These crania were excavated from the site of Nuvakwewtaqa located in the middle of the Coconino National Forest of north-central Arizona. Unfortunately, the site was heavily looted through pot-hunter activity, leading to a large collection of commingle remains. The objectives of this study are summarized into three basic question words: who, where, and how. More specifically: [1] whether there is a relationship between age/sex and being a victim of scalping; [2] whether there is a relationship between the burial location and having been scalped; and, [3] whether the age/sex of an individual affected the manner in which they were scalped. For this scalping analysis, three statistical tests were used: Fisher's exact test, Chi-Square test and two-sample t-tests.

**The Use of Ecological Niche Modeling Methods to Test Models of Neanderthal Extinction**

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The Ebro Frontier Model was originally created to explain the distribution of, and transition between, Middle and Upper Paleolithic archaeological sites on the Iberian Peninsula. In comparison, sites containing diagnostic hominin remains pertinent to the period are scarce. This model produced a set of hypotheses that, broadly speaking, imply that the niche parameters for Neanderthals and early modern humans (EMH) were exclusive until 30,000 years ago (ky b.p.), after which their parameters began to overlap and these two groups were then ecologically allowed to come into contact and compete for resources and/or experience admixture. Previous research on this topic using ecological niche modeling methods (ENM) focuses exclusively on using archaeological datasets as indicators of population presence and geographic range. The predictions of the Ebro Frontier Model have been greatly debated within the literature, with conclusions both supporting and disputing the model's validity. This project uses the predictive ecological niche modeling program openModeller Desktop version 1.1.0, which includes the Genetic Algorithm for Rule-set Prediction (GARP) and MAXENT, to investigate the validity of using traditional ENMs to explore the niche parameters of Neanderthals and EMH.

Small sample sizes are the greatest obstacle facing the viability of ENM methods with a theoretically conservative dataset of sites containing diagnostic hominin remains as indicators of populational affinity and distribution. However, this project indicates that, while small, the sample sizes are large enough to return a statistically accurate and significant result. This indicates that ENM methods are a viable tool in investigating hominin evolution.

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#### **Calcified structures as potential evidence of atherosclerosis associated with human skeletal remains from Amara West (1300–800BC)**

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While conclusive evidence of atherosclerosis, one of the most common forms of CVD (cardiovascular disease) today, is relatively frequently reported in mummified human remains from different geographical, environmental, chronological and social backgrounds, evidence associated with skeletal human remains on the other hand is almost completely absent from the archaeological record. This paper presents calcified structures found in association with skeletal human remains of five individuals buried in the cemeteries of the settlement of Amara West, Sudan (1300-800BC) excavated between 2009 and 2013. In three middle adult individuals the “artefacts” were recovered from the chest area, in a middle adult female from the abdominal area, as well as alongside the femur of another middle adult female. Based on morphology, in situ location, scanning electron microscopy and radiography, they are likely to be identified as calcified atherosclerotic plaques, or evidence of advanced atherosclerosis, one of the most common forms of CVD today.

The cultural and environmental background of the inhabitants of Amara West, accessible through archaeological and palaeoenvironmental research on the settlement and surrounding habitat, together with a detailed palaeopathological analysis of the skeletons, reveals several risk factors well evidenced in modern medical research that would have facilitated the formation of advanced atherosclerosis. They include exposure to indoor air pollution, dietary habits, chronic infections and dental disease. These risk factors would have likely impacted on human populations way back into antiquity. The findings therefore further provide support to the notion that CVD are indeed an ancient threat to human health.

#### **Phylogeny, ecology and craniodental evolution in the atelid primates**

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The atelids (family Atelidae) are a monophyletic clade including *Alouatta*, *Ateles*, *Brachyteles* and *Lagothrix* that represent one of the major radiations of South and Central American primates (platyrrhines), with considerable diversity in morphology, body and brain size, locomotion, diet, social systems and behavioural ecology. Molecular phylogenetic studies strongly support a *Lagothrix-Brachyteles* clade sister to *Ateles*, whereas past morphology-based studies have largely inferred alternative phylogenetic relationships.

We examined the phylogenetic signal in the atelid cranium using distance-based phylogenetic methods and geometric morphometric data collected from 327 adult specimens belonging to 16 atelid taxa and incorporated a jack-knife procedure to quantify node support. Phylogenetic analysis was performed separately for morphometric data from the whole skull, face and cranial base, and with several alternative outgroups. Phylogenetic analysis of facial morphology supported the atelid molecular phylogeny and a *Lagothrix-Brachyteles* sister relationship, whereas cranial base and whole skull data supported *Ateles-Lagothrix* or *Alouatta-Brachyteles* clades.

The presence of a phylogenetic signal in the atelid face provides further evidence that congruence between molecular and morphological phylogenetics is module and clade-specific, whilst support for alternative clades from the whole skull and cranial base highlight the importance of ecology and diet in shaping atelid craniodental morphology. The contribution of phylogeny and ecology, and their impact on phylogenetic analysis, requires further investigation to develop robust and reliable methods that accurately infer the relationships between extant, and fossil, taxa.

#### **Effects of Parasitism on Fecundity and Life History in Human Females**

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In animal studies, parasitism decreases overall reproductive effort, consistent with costs of both parasitism and reproduction. Yet when examined across the lifespan, parasitism can increase

precocious reproduction, as effort is shifted earlier due to increased mortality or reproductive senescence, a response known as fecundity compensation. To date, studies have largely examined short-lived birds and rodents, and no studies have examined effects in humans. Here, we investigate whether intestinal parasites affect human fecundity with seven years of longitudinal data from the Tsimane, Bolivian forager-horticulturalists experiencing both natural fertility and a 70% helminth infection prevalence. We observed 184 nulliparous women, 45 of whom became pregnant during the study period, and 511 intervals following births for 432 women. Cox proportional hazard models were used to examine the effects of infection on pregnancy hazard, controlling for BMI. Hookworm was associated with both delayed first pregnancy (HR=0.38; p=0.003, median age 19.1 vs. 15.9) and extended interbirth intervals (HR=0.77, p=0.042; median IBI at age 20: 36.8 vs 33.9 months). In contrast, *A. lumbricoides* was associated with earlier first pregnancy (HR=2.24, p=0.002, median age 14.6) and shortened IBIs at younger, but not older, ages (at age 20: HR=2.33, p<0.001, median 27.1 months). Although parasitism affected pregnancy, odds of infection were not affected by reproductive state. While the effect of hookworm suggests overall costs, infection with *A. lumbricoides*, which often co-occurs with hookworm, suggests fecundity compensation. Our results suggest that helminths have consequences for human fertility, and provide an additional avenue for understanding demographic changes with modernization.

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#### **Assessing Oral Health Differences in Socially Distinct Classic Period Maya Populations**

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Social inequality in Classic Period Maya populations is manifested through resource access and overall health. Individuals from the urban centers Buenavista del Cayo and Cahal Pech possessed high status, individuals from structures Angel and Archangel were of middle status, and individuals from the community of Guerra were non-elite. Social distinctions in architecture and material culture between these classes are apparent, but whether social stratification influences access to resources and dietary behaviors in this Western Belize Valley region is uncertain. This study uses oral health indicators of these three Classic Maya social classes to test if social stratification had a differential impact on local access to resources.



## AAPA Abstracts

Frequencies of caries, abscesses, hypoplastic defects, and calculus were recorded from 46 individuals: 16 ascribed, 12 achieved, and 18 non-elite. Using an ANOVA, we determined that abscessing was the only significant difference ( $p=0.002$ ) between the three sites. A post-hoc test adjusting for age did not show any significant difference between individual sites, however the data indicate a tendency for abscessing to increase with age, and Cahal Pech consistently displaying higher frequencies at all ages. Based on caries, hypoplastic defects, and calculus frequencies, it appears these three classes had similar access to resources. However, differences in abscess frequencies could indicate differences in dietary behavior, particularly food processing techniques.

*This research is part of the Mopan-Macal Triangle Archaeological Project which was supported by the National Science Foundation and San Diego State University.*

#### **Boldness in wild vervet monkeys: individual differences and consistency across contexts**

MARYJKA B. BLASZCZYK. Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

Animal personality refers to individual differences in behavior that are consistent over time and across contexts. A commonly studied personality trait is "boldness", generally interpreted as variation in individuals' propensities to take risks. Exploration of novel objects may involve an inherent degree of risk-taking, therefore, individuals that are more willing to interact with novel objects are expected to show greater risk-taking in other contexts. I compared boldness across three diverse contexts in wild vervets, *Chlorocebus pygerythrus*. I recorded individual's responses to distinct novel objects in three field experiments for 40 subadult and adult monkeys. I also derived a "snake inspection score" for these individuals based on how frequently they inspected naturally occurring snakes, recorded *ad libitum* during group follows. Finally, experienced observers subjectively ranked all monkeys according to how close they generally allowed observers to approach during focal animal follows. Animal's novel object response scores were consistent across tests, and individuals' mean neophilia scores were positively correlated with their frequency of snake inspections. Observers' boldness rankings were correlated with snake inspection frequency, but not with neophilia scores. Males had higher boldness scores than females across all contexts, and subadults had higher neophilia and snake inspection scores than adults. Subadult males had significantly higher scores than adult females in the novel object and snake inspection contexts. This study shows boldness to be broadly consistent across contexts in wild vervets, and age-sex class differences are hypothesized to arise from divergent costs and

benefits to boldness within a life-history framework.

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#### **From the mouths of babes: is Moorrees method appropriate for age estimation of Prehistoric Native American children?**

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Methods for estimating age-at-death are derived from modern Euro-American reference samples. Application of a standard from a geographically and temporally disparate population to archaeological samples assumes that interpopulation variation in timing and pattern of growth between them is negligible. This assumption has implications for reliability of age estimation standards, but few have examined or addressed the validity of such standards applied to non-European archaeological populations. This project tests the appropriateness of using temporally and geographically-biased reference samples for age-at-death estimation of prehistoric Native American juveniles from the Ohio Valley.

Teeth are excellent chronological archives, providing a baseline for measuring disruption and variation in physiological growth of the skeleton. Crown formation times, ages-at-death, and crown formation sequences of 38 juveniles with developing permanent dentition from three archaeological sites in the Ohio Valley were calculated from perikymata and histological incremental microstructures of enamel. Age results were compared via RMA regression and concordance correlations to those obtained using the Moorrees dental formation method. In this manner the accuracy of the methods was assumed if differences were negligible.

Results indicate high correlation (0.9312-0.9873;  $p<0.0001$ ) of estimated ages between the two methods for children one to ten years with an absolute difference in of 2.6- 4.1 months. This suggests that despite contextual disparities between reference and target populations, Moorrees' method provides accurate age predictions for prehistoric Native American children through ten years of age. Conversely, M2 and M3 appear developmentally accelerated in the target population, suggesting that variation is not negligible during later growth.

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#### **Relative Clavicle Length in Modern Human Males and Females from Kellis 2, Dakhleh Oasis, Egypt**

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Claviculohumeral indices in modern humans may yield false impressions of relative clavicle length since modern humans tend to show left-biased clavicle length asymmetry and right-biased humerus length asymmetry. Ideally, an independent measure of body size should be used to assess relative clavicle length. This study explores the relationship between clavicle length and estimated body mass, and clavicle length and estimated stature in an adult sample from the Kellis 2 cemetery, Dakhleh Oasis, Egypt. The relationship between clavicle length and body mass is isometric and is not significantly different between the sexes. Clavicle length scales to stature with positive allometry and the magnitude of the relationship between clavicle length and stature is significantly different between the sexes. Clavicle length changes more quickly as stature changes in males compared to females. Results from this study suggest that clavicle length should be scaled to body mass rather than to stature when comparing relative clavicle lengths between the sexes. Additional modern human samples should be examined to test if these patterns are generally universal among modern human groups.

#### **Early Childhood Health and Status in Tiwanaku Society**

DEBORAH E. BLOM, EMILY A. SHEA, JAMES P. ALLEN and KATHERINE M. GOLDE. Anthropology, University of Vermont.

The Chen Chen site in the Moquegua Valley of Southern Peru is the source of one of the largest archaeological skeletal collections in Peru and has been the focus of significant research into the formation of the Tiwanaku state (AD 500-1100), as it impacted population movement, local identity, and quality of life. A new focus of study in this area is the impact of state and local forces on childhood health and inequality. Linear enamel hypoplasias (LEH) results from poor childhood health and provide a powerful means for addressing these issues. Analysis reveals no significant differences in LEH development by sex, age at death, or cranial modification, but show that individuals living in the lowlands generally have higher rates of LEH than those from the Tiwanaku highland sites. Developmental timing of LEH using methods from Reid and Dean (2000, 2006) indicate that the highest frequencies of LEH development occur later in childhood than that reported for the majority of studies. Using ethnographic parallels and the presence of wooden spoons in the



mortuary record, we conclude that the later period of stress observed in this sample may represent the period in a child's life when they transitioned socially from a protected infant to an older child, exposed to the physical and social stressors of labor. We also present a comparison of data from previous studies using macroscopic recording of linear enamel hypoplasias to those from a new microscopic method using removable dye, which is promising for better discerning defects.

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#### **Late Pliocene to Late Pleistocene paleoenvironments in southwestern Kenya from carbon isotopes in herbivore tooth enamel**

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While a number of hypotheses have been proposed directly linking hominin evolution with environmental change, the breadth of available terrestrial environments across eastern Africa over the past 3 million years remains poorly understood. We use stable carbon isotopes in herbivore tooth enamel from fossil- and artifact-bearing deposits in the Lake Victoria region, southwestern Kenya to reconstruct paleoenvironmental conditions from the Late Pliocene to Late Pleistocene. We sampled 386 fossil teeth from seven time intervals, including material from the Late Pliocene Rawi Formation, the Early-to-Middle Pleistocene Kanjera Formation, the late Early Pleistocene Kasibos Formation, and the Late Pleistocene exposures at Karungu. Fossils sampled include all major large mammalian herbivore taxa. The distribution of enamel carbon isotope values from each time interval includes a peak at or greater than -1‰, indicating that most herbivores had a C<sub>4</sub>-dominated diet. Isotope values from Kanjera North Bed 5 have an additional, lower peak at -

3‰ that indicates many herbivores also had a mixed C<sub>3</sub>/C<sub>4</sub> diet. All time intervals except Rawi include 1-5 individuals with C<sub>3</sub>-dominated diets, but none consuming closed-canopy forest vegetation. Our results demonstrate that from the Late Pliocene through the Pleistocene herbivores in southwestern Kenya primarily relied on C<sub>4</sub> resources, which indicates that paleoenvironments in this region were characterized by an abundance of grass during periods of fossil mammal preservation. These findings indicate that the spectrum of habitats available to hominins in eastern Africa included those associated with the savanna biome at multiple time intervals over the last 3 million years.

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#### **A Radiographic Approach to Age Estimation of the Subadult Knee Joint: A New Standard**

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Age estimation in subadults is primarily focused on epiphysis appearance and fusion. However, current estimates (Schaefer et al., 2009; Scheuer and Black, 2000) are based on older longitudinal studies that may not represent modern subadult growth. Additionally, some studies, such as Elgenmark (1946), include data from premature births without documented intrauterine age, which truncates ossification information from epiphyses that appear prior to birth.

To address this issue, over 1,800 radiographic images of the knee joint from Patricia (Pediatric Radiology Interactive Atlas: [http://math.mercyhurst.edu/~sousley/databases/radiographic\\_database/](http://math.mercyhurst.edu/~sousley/databases/radiographic_database/)), were scored for the appearance of the epiphyses of the knee and the patella. Individuals with obvious growth disturbances were excluded. Binary logistic regression was used to model appearance times.

The results suggest that secular changes are present in some epiphyses. For example, a 50% probability for the appearance of the proximal tibia in boys and girls was 0.75 months in Elgenmark (1946), 0.38 months in Garn et. al (1967), and 0.2 months using Patricia. The importance of prenatal information (especially intrauterine age) is illustrated by the distal femoral epiphysis. Elgenmark's results, which include preterm children, have a 50% probability for appearance at 0.5 months, while the Patricia estimate is 32 intrauterine weeks. Furthermore, 95% of individuals from Patricia exhibit the distal femoral epiphysis by one month of age. The appearance of other epiphyses in Patricia

show rough agreement or are somewhat behind older standards.

This study illustrates the need for new age estimation standards that are based on modern samples, prenatal information, and current methodological approaches.

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#### **Integrating anthropological perspectives on race, human genetic variation, and health disparities in medical education**

DEBORAH A. BOLNICK. Department of Anthropology and Population Research Center, University of Texas at Austin.

Despite major public health initiatives over the last two decades, significant disparities persist between racially defined groups in the prevalence of disease and in health outcomes for common causes of morbidity and mortality in the United States. Many of these disparities have increased, rather than decreased, in recent years, making it critical that we develop new and creative strategies to address such inequities. In particular, there is an urgent need for more effective medical education that incorporates current knowledge about the complexities of race, human genetic variation, and the causes of these disparities, as well as training to improve clinical practice, diagnosis, and treatment for racially diverse patient populations.

As the University of Texas at Austin (UT) prepares to open the first major new medical school in the U.S. in 50 years, we have had a unique opportunity to develop innovative, evidence-based, and anthropologically informed medical training that will help achieve these goals. In this presentation, I will discuss the learning objectives and pedagogical approaches we have developed, including examples of learning modules and clinical case studies designed to be integrated throughout the years of preclinical and clinical medical training. I will also discuss a continuing medical education (CME) conference and workshop held at UT to help educate present and future health practitioners about human genomic variation, race, health disparities, and the social, environmental, and genetic determinants of health.

#### **Wet Grave Deadspace: Spatial Analysis of Cemeteries within New Orleans**

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Located in a geologically unsound environment that is prone to flooding, storm surges and

vector-borne epidemics that have historically killed thousands of individuals, New Orleans has earned its alternative nickname "The Wet Grave." However, very little attention has been attributed to the water's impact on cemeteries and their remains beyond storm recovery and DMORT efforts following Hurricane Katrina. These Cities of the Dead were analyzed spatially for location, elevation and flood risk in order to isolate if there is a relationship between cemetery location, flooding and potential age of establishment.

To conduct as full a survey as ever recorded for New Orleans, 42 cemetery GPS coordinates located via Google Maps were incorporated into ArcMap with U.S. Census Bureau shapefiles and National Map Viewer DEM rasters. NFIP maps from FEMA were further overlaid via georeferencing to determine the 100- and 500-year storm boundaries. Despite only 9 cemeteries located above sea level, 31 out of 42 cemeteries are protected within the 500-year flood levels. Spatially, the cemeteries appear to outline a central basin region, implying an intentional avoidance of a central habitation area. In conjunction with a rough spatial pattern of temporal progression, it appears that date of establishment and flood risk indicate a relationship suggestive of cemeteries located on available land within the outskirts of urban sprawl in contrast to areas of higher elevation.

#### **An overall picture of the pelvis of the hominins from the Middle Pleistocene Sima de los Huesos site (Spain)**

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The Sima de los Huesos (SH) is one of the important cave sites located in the Sierra de Atapuerca (Spain). To date, more than 6500 human remains have been recovered and they have been attributed to at least 28 individuals. The SH hominins are dated to around 430 ka and they are considered phylogenetically related to Neandertals. The sample contains, an important collection of pelvic remains (os coxae and sacrum), comprising more than 150 fragments that represent a minimum number of 41 elements and a minimum number of 17 individuals. SH pelvis are characterized by a marked robusticity (e.g. iliac tubercle and ischial and iliac tuberosities) and large overall dimensions; they are broader, taller and more antero-posteriorly widened pelvis than modern humans (MH). Unsurprisingly, this is also true for the isolated os coxae and sacrum; the total length of the complete hip bone and sacrum and of the ischium, ilium and pubis are conspicuously above MH. SH pelvis particularly stand out for their large transverse dimensions (e.g. bi-iliac and sacral breadths) that distinguish them from

MH and Neandertals. The SH pelvic remains are also distinct from MH in having an anteriorly located acetabulocrystal buttress, a conspicuous supraacetabular groove, a second sacral promontory and a thin and rectangular, plate-like superior pubic ramus. However, SH pelvis do not show the extreme flattening of the superior pubic ramus of Neandertals. In most of these features, the morphology of the SH pelvis appears to be largely primitive for the genus *Homo*.

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#### **Self-similarity is the appropriate null model for GMM studies of integration**

FRED L. BOOKSTEIN. Department of Anthropology, University of Vienna, Department of Statistics, University of Washington.

Current methods for quantifying the notion of integration in geometric morphometric (GMM) data sets are wholly unsatisfactory for purposes of biological explanation. Their methodological ineptitude owes mainly to their reliance on inappropriate null models such as noncorrelation or nonmodularity and on permutation tests across landmarks, tests that are almost never relevant to well-designed GMM investigations. For studies of integration to be meaningful, their null models must conceivably be realistic: they must at least occasionally be encountered in real organismal-level data. This presentation explains and exemplifies such a null model, the pattern of *self-similarity* arising when our familiar thin-plate splines are reinterpreted as intrinsic prediction functions. In this new approach, integration is null when any particular shape, such as a quadrilateral of mean landmark locations, has the same empirical nonaffine shape distribution regardless of its size, location, or orientation on the template. Integration is present when the distribution of a shape becomes small at a rate faster than its geometric scale shrinks. And integration is negative in, for example, the completely unrealistic "offset isotropic" (Procrustes) shape distributions, which, far from being supralinear in geometric scale, actually scale to the inverse of geometry, rendering them totally unsuitable for realistic organismal modeling. My presentation will argue the cogency of this approach in two real examples, one (the Vilmann rodent neural skull data) where integration can be shown to be present along with modularity, and another (the midcurve of the human corpus callosum) for which a self-similarity finding is indicated instead.

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#### **Sexual behavior, stress, and constraint in female choice in bonobos**

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Male primates utilize many strategies to maximize reproductive success, including the attainment of high rank and the sexual coercion of females. Male chimpanzee aggression against females is known to elevate cortisol levels and influence female sexual proceptive and receptive behaviors. In contrast, bonobo females can hold significant power positions and may therefore be less constrained in their sexual behavior by male aggression. Data on mating behavior and preference were recorded for the Columbus Zoo bonobo colony. Urine samples were collected from all individuals (N=17) and assayed for the stress hormone cortisol. All age and sex classes showed proceptive and receptive behaviors. All age-sex classes were equally receptive and did not differ in their response to solicitations for copulations (G=8.313; p=0.140). Cycling females were most proceptive towards the dominant male (G=163.999; p<0.001) and were most receptive towards the son of the alpha female (G=172.037; p<0.001). High-ranking females were only proceptive to the son of the alpha female when the alpha female was present (N=9). There were 21 observations of male sexual coercion against females. The son of the alpha female engaged in significantly more sexual coercion than other males (G=63.676; p<0.001). In addition, mean urinary cortisol levels were negatively correlated with receptive behaviors in females (r=-0.547; p<0.05). We conclude that bonobo females may be more constrained in mate choice than previously thought and that this may be the result of the influence of higher ranking females that benefits their sons.

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#### **3-D Morphometric Analysis of the Primate Elbow Joint**

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Large body size requires limb joints capable of supporting large weights, and species exhibiting sexual size dimorphism may necessitate joint size differences between the sexes. If habitual behavior differs with body size, one may expect to see significant variation in joint morphology between species and the sexes within species. The following analysis tests two hypotheses: (1) that significant differences in joint size between males and females correlate with the magnitude of sexual dimorphism and (2) that there is significant interspecific variance in joint shape between males and females of the same species.

The first hypothesis is tested by taking principle component scores from the first two components of a principle component analysis (PCA) with full tangent space and Procrustes form space projection and subjecting them to an analysis of variance (ANOVA) to see if a significant amount of variance exists between sexes for each observed species. The second hypothesis is tested in the same way, the only difference being that the PCA utilizes solely a full tangent space projection in order to nullify size differences in variance. The magnitude of sexual dimorphism is found to correlate with differences in joint size. However, there is no significant interspecific variation in shape between males and females in the same species. The analysis did not have a consistent sample size for all sexes or species and the sample sizes were all relatively small. An analysis with larger samples and greater consistency will be needed to confirm the inferred conclusions.

#### Who hunts lemurs and why do they hunt them?

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Why do people eat threatened lemurs, even when they know their livelihoods will suffer once the species are lost? How do we identify households that are at high risk of hunting lemurs, to increase the chance that combined human-livelihood and conservation efforts actually reach hunters? Madagascar is currently facing a duel biodiversity and public health crisis. As the island's endemic lemurs have swiftly become the earth's most endangered mammals, the food security of Madagascar's people has decreased to nearly last in the world. There is a rising crescendo of research implicating the need to address the complex interactions of wildlife and humans. Here we examine the incentives of hunters who illegally trap endangered lemurs in NE Madagascar, with the goal of helping to design effective conservation policies. We asked members of 100% of a focal village's households over 600 questions about their daily resource use, socioeconomics, health, and micro- and macro-sociopolitical resource regulation. Of numerous potential predictor variables (including demographics, human health, wealth, education, involvement in ecotourism, and other cultural factors) only an individual's sex, health, and wealth accurately predicted a person's decision to engage in illegal lemur trapping. Notably, working in ecotourism had no impact on either the decision to trap or the number of times a person reported eating endangered species over the last year. Our findings support growing evidence that the key to successful lemur conservation may be improving rural human health and welfare.

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#### Female rank and infanticide in Nepal Gray langurs

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In several matrilineal cercopithecine primates female dominance rank translates into improved access to food, better nutritional condition, and even higher reproductive success. The benefits of an age-inversed hierarchy as described for female langurs are, however, less well understood. The youngest reproducing females occupy the highest ranks and older females are found at the bottom of the hierarchy. This system is inherently unstable and rank changes much more frequently compared to matrilineal cercopithecines. Nevertheless, in a given situation, most dominance relationships are decided and hierarchies are linear bearing the question what the potential benefits of rank may be in such a system? Here we investigated if maternal rank affects the rate of infanticide using data for two wild multimale groups of Nepal Gray langurs (*Semnopithecus schistaceus*) from Ramnagar, Nepal. In this population infanticide by adult males accounted for 32% of infant mortality. Between 1991 and 1996, 35 attacks/infanticides were documented. In 29 of these cases data on dyadic displacement interactions were available so that maternal rank could be determined. Females were divided into 2 rank classes (low and high). Compared to all infants present, offspring of low-ranking mothers were targeted significantly more frequently by males (G-test,  $p's < 0.01$ ). Of the 6 infants who died, 5 had a low-ranking mother. Together, this suggests a strong effect of maternal rank on offspring survival although the proximate mechanisms still have to be disclosed. Future studies will have to show if infanticide avoidance can be added as potential rank benefit in nonhuman primates.

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#### The Out of Africa expansion affected accumulation of deleterious alleles in human genomes

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The Out of Africa dispersal ~50,000 years ago is characterized by a pattern of serial founder effects as modern humans expanded into multiple continents. From population genetic theory, we expect an increase in the proportion of deleterious alleles, and therefore mutational load, in populations that have undergone a combination of bottlenecks and expansion. To test this hypothesis, we have sequenced full genomes and high-coverage exomes from over 50 individuals from 7 human populations, establishing a picture of genomic diversity in geographically divergent groups from Namibia, Congo, Algeria, Pakistan, Cambodia, Siberia and Mexico. We find that individuals vary in the number of predicted large effect deleterious alleles they carry. We use a model of mutational load and incorporate different selection coefficients and vary the deleterious effect of heterozygotes (dominance). We estimate an increased load in populations outside of Africa particularly if most deleterious variants are recessive. We show via spatially explicit simulations that the distributions of deleterious alleles are consistent with the Out of Africa dispersal.

We conclude that purifying selection historically differed in its efficacy among populations. We conclude that unless under extreme selection, most deleterious mutations in genic regions have evolved neutrally in non-African populations.

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First complete, articulated hand of an adult Eocene primate with 3D preservation

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Knowledge of functional anatomy of Eocene euprimates from North America has been limited by the lack of specimens completely preserving hands and feet with detailed documentation of digit ray associations and articulations. While several specimens of Eocene European



adapiforms include articulated extremities, crushing obscures their morphological details and some are sub-adults. A new adult specimen of *Notharctus tenebrosus* ("Prosimii", Adapiformes), UWBM-88873, from the Cottonwood Creek area of the Bridger Formation in southwest Wyoming includes much of a skull and skeleton, including a fully articulated right hand, forelimb, and parts of a semi-articulated left hand. A previously described hand of *N. tenebrosus*, AMNH-FM-127167, lacked documentation of *in situ* articulations of some phalanges comprising digit rays. It also has a fragmented metacarpal III and fragmentary intermediate phalanges III-IV, meaning that manual axony measurements could not be made, nor could standard prehensibility measures be computed without estimation. The new specimen fills in these important gaps in knowledge and preserves joint postures at death, providing new data to address hypotheses regarding locomotion and foraging patterns in early euprimates. We microCT scanned, digitally extracted, and analyzed these elements. The pattern of digit ray lengths, preserved digit postures, and estimated levels of inter-metacarpal divergence strongly support reconstruction of an entaxonic or schizaxonic grasp pattern in *Notharctus* as is seen in lorises and sometimes cheirogaleids, in which digit II is not relied on in grasping. Finally, intrinsic hand proportions reflect hyperprehensibility like those of tarsiers and Messel adapiforms, but contrasting with adapines and most extant primates.

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#### Variation in lateral plantar process morphology and implications for bipedalism in *Australopithecus*

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The calcaneal lateral plantar process (LPP) has been proposed as critical to the evolution of the hominin foot and walking mechanics of bipedal hominins. In humans, the LPP is an inferolateral protuberance that increases posterior calcaneal volume and has been hypothesized to help dissipate the forces endured at heel-strike. In contrast, extant apes possess a homologous flange that is dorsally positioned. LPP positions in *Australopithecus afarensis* and *A. sediba* have been qualitatively described in the literature and included in arguments regarding bipedalism in these species. This study provides the first quantitative and comparative assessment of LPP position in several populations of modern humans (n=132) and great apes (n=63).

Measurements were taken on photographs of all calcanei articulated with their associated tali (except A.L. 333-8, -55 which were articulated with A.L. 333-147), and kept standard by keeping the talar trochlea parallel to the horizontal plane. Elevation of the LPP was measured as the ratio between height of the posterior calcaneal tuber and distance from the base of the tuber to the height of the apex of the LPP. Though variable, humans (16.7 +/- 6.5 [1.1-34.3]) have an LPP significantly (p<0.001) more plantar than great apes (44.4 +/- 7.9 [23.4-58.1]). Despite some overlap between apes and humans in LPP position, *A. afarensis* is human-like (14.7 +/- 5.9) while *A. sediba* (41.6) resembles the ape condition. These results have implications for the nature of bipedality in these species.

#### Rethinking the Forensic Anthropology Classroom: Pedagogy in the 21<sup>st</sup> Century

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Recently, STEM classrooms have broken the traditional teaching model that presents the student modules in the following sequence—podium instruction, laboratory exercises, and homework, by adopting a flipped classroom. The model asks the student to prepare upcoming topics prior to attending class; thereby, allowing the student to actively engage in learning during inquiry activities in the laboratory that now occurs at the beginning of class. This is followed by a debriefing to reinforce information.

In the summer of 2014, we applied this model to middle school students who participated in a Summer Research Opportunity (SRO) offered at Florida Gulf Coast University through the Whitaker Center for STEM Education and the Forensic Studies Human Identification and Trauma Analysis (HITA) Master's program. The SRO students assisted the HITA anthropologists in conducting an excavation of Florida wild pigs (*Sus scrofa*) and collecting environmental data to test the applicability of postmortem interval and time-since-burial equations developed in Knoxville, Tennessee.

During indoor laboratory and outdoor sessions, guided inquiry activities containing critical thinking questions were facilitated by the program instructors. Additionally, articles supplied to students each day contained material for the next module. This model accesses high order thinking skills including analysis and synthesis. The authors observed and recorded student development, leadership, and problem solving milestones. Some examples include peer-to-peer teaching opportunities and process skill development during group discussions. The observations and examples of student

engagement and critical thinking will be discussed during this session in addition to field school processes for middle school age students.

#### A volumetric mass estimation technique for biological anthropology: 'Convex hull' scaling in modern primates and applications to fossil hominids

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Body mass is a critical constraint on an organism's ecology, physiology and biomechanics, and is a required input parameter in many ecological and functional analyses. Whilst most techniques for fossil mass estimation exploit the relationship between body mass and a postcranial dimension (such as femoral circumference or bi-iliac breadth) in modern species, recent advances in 3D-imaging technology have led to increased interest in volumetric mass estimation techniques in vertebrate palaeontology.

We present a volumetric 'convex hull' method for reconstructing body mass of fossil hominids. The cadavers of a diverse sample of modern primates were CT scanned and minimum volume ("shrink-wrap") convex polytopes were fitted to the functional units of the skeletons. The relationship between total convex hull volume and body mass was calculated using phylogenetically corrected and uncorrected least squares methods. The best-performing predictive equation is characterized by high correlation coefficients, low mean square errors and low mean percentage prediction error ( $r^2=0.99$ , MSE=0.004, %PE=10.9%) and compares favourably to predictive models based on limb bone dimensions alone.

Volumetric mass estimation techniques benefit from incorporating the maximum amount of information available from the specimen into an estimate and are less vulnerable to biasing by single robust/gracile postcranial elements. However a considerable proportion of the fossil skeleton must be preserved and the material rearticulated (physically or virtually) to construct a volumetric model. We therefore discuss the future potential for volumetric mass estimation in palaeoanthropology, given the fragmentary nature of the fossil record and uncertainties associated with reconstruction of the hominid ribcage in particular.

#### The ontogeny of foraging behavior in wild chimpanzees (*Pan troglodytes schweinfurthii*)

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Primates have an extended period of development before they reach adulthood. One explanation for their delayed maturation is that they need a long time to learn complex foraging behaviors. Chimpanzees provide a good opportunity to test this hypothesis because they eat diverse foods, some of which require extensive handling. To explore the ontogeny of foraging behavior in chimpanzees, we used 3 years of behavioral data (2010-2013) from 28 immature and 29 adult individuals of the Kanyawara community in Kibale National Park, Uganda. We compared several measures of feeding behavior among infants, juveniles, adolescents and adults, including total daily feeding time, proportion of time spent feeding by food type, distribution of feeding time over the day, and fruit ingestion rates (number of food items eaten per minute of feeding). By late infancy chimpanzees displayed adult-like diurnal feeding peaks and ate fruit and fibrous foods at comparable proportions to adults; however, they spent a mean of only 24.5% of total time feeding, significantly less than adults ( $p = 0.002$ ), whereas juvenile feeding time was equivalent to adult levels (juveniles: mean = 41.0%; adults: mean = 42.8%;  $p = 0.47$ ). Furthermore, ingestion rates displayed the slowest developmental trajectory of any feeding measure, remaining below adult levels until adolescence. If extended juvenility functions to allow the learning of complex feeding behavior, these data suggest that ingestion rates may be constrained by foraging complexity. Future studies should assess whether the development of ingestion rates varies by the difficulty involved in processing different foods.

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#### **Age Estimation from Osteoarthritis of the Shoulder in Modern North Americans**

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A visual examination of the presence and severity of osteoarthritis (OA) in four joint surfaces of the shoulder was conducted using 206 modern North American skeletons of White ancestry. The goal was to establish the correlation between OA and age and use this relationship to derive forensically significant age intervals, while also assessing the method's applicability to fragmentary contexts. Evidence of lipping, surface porosity, osteophyte formation, and eburnation were recorded on an

ordinal scale, along with the percentage of the joint surface affected. Ordinal scores were summed to create composite scores which were assigned a specific phase. Sex differences were not present; however, bilateral asymmetry was statistically significant. Spearman's correlation showed a positive relationship between each composite variable and age. The right shoulder demonstrated the strongest correlation (0.754), while the left shoulder was slightly lower (0.737). Transition analysis and Bayesian statistics generated phase-related age estimates based on highest posterior density regions. Transition analysis revealed that the right shoulder tended to develop phase-related changes earlier than the left. Best age estimates for the highest posterior density regions at the 90th and 50th percentile were into the ninth decade for both composite variables. Low levels of intraobserver error were detected. Interobserver error was not analyzed, although the subjectivity of OA coding is likely of practical significance. Shoulder osteoarthritis can plausibly be applied to fragmentary or incomplete contexts due to anatomical placement and density. The proposed method quantifies new information about the variation of OA in a forensically and archaeologically practical manner.

#### **The archaeological signatures of Late Pleistocene populations' dynamics of archaic and modern humans in Arabia and Southwestern Asia**

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Since the 1990s when the Out of Africa hypothesis for the expansion of modern humans out of Africa gained near universal acceptance, researchers have intensified their study of the geographic regions adjacent to Africa with the goal of establishing an empirical archaeological record of this process. Work in Tübingen has focused on new field work in Southern Arabia, Syria and Iran. While the skeletal record of human evolution in these regions remains poor, new fieldwork is beginning to allow us to trace the archaeological signature of the spread of modern humans out of Africa. The earlier phase of this process lies in the Middle Paleolithic, and the later phase in the early Upper Paleolithic. Based on our extensive survey projects and excavations at sites including Jebel Faya (UAE), Wadi Mushkuna (Syria), Ghar-e Boof (Iran) and complementary information from other projects, this paper summarizes current research on the population movements of late archaic and early modern humans in Arabia and Southwestern Asia and addresses how the archaeological record relates to competing hypotheses for this critical phase of human evolution.

#### **Evolution of primate early genomic responses to severe infection**

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Primates exhibit striking differences in susceptibility to multiple pathogens that are major causes of severe infections in humans. For example, humans are highly susceptible to Gram-negative bacterial sepsis and chronic hepatitis C infection, while other many other catarrhines are not. Innate immunity is strongly implicated in such disease progression, however a lack of comparative immune response data from major primate clades inhibits our understanding of how this response has evolved in susceptible and resistant primates. Here we report a genome-wide comparative study of primate innate immune responses to bacterial and viral molecules associated with severe infections. We stimulated leukocytes from humans, chimpanzees, rhesus macaques, olive baboons and ring-tailed lemurs (outgroup) with molecular motifs representing Gram-negative bacterial (LPS from *E.coli*) and singled stranded RNA viral (Gardiquimod) pathogens. Blood was stimulated for 4 and 24 hours and leukocyte responses assessed via RNA-seq. Overall, whole transcriptome responses agreed with species phylogeny. We found a considerable number of genes and regulatory networks that showed species-specific responses (SSR) to both immune-stimuli. Interestingly, the number of species-specific immune responses became increasingly divergent over 24 hours of stimulation. We show that a significant number of genes associated in SSR have signatures of rapid evolution in either their coding sequence or promoter region, which suggests adaptive lineage-specific change. We also found considerable overlap between species-specific response genes and genes known to be associated with susceptibility to immune-related disorders in humans, which suggests that the observed changes contribute to inter-species differences in immunity and severe infection manifestation.

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### New Micro-CT Scan of the Imbedded Prefrontal of the Taung endocast

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The Taung endocast remains one of the most important and controversial hominin remains some 90 years after its discovery. Taung provides some of the best and earliest evidence for hominin brain reorganization. However, a limitation of Taung is that the endocast is not complete with some of the most important regions, namely the temporal and frontal poles, still firmly attached to the skull. Using Micro-CT scanning it is possible to extract these regions with a level of detail previously only available on the natural endocast itself. Extraction of the prefrontal regions from the frontal bone using Micro-CT scans reveals a slight degree of asymmetry. While the general morphology of these regions indicates that *A. africanus* possessed a prefrontal region similar to that of chimpanzees, extraction of the frontal poles from the overlying bone using Micro-CT reveals a slight degree of asymmetry reminiscent of later hominin brain evolution. While further study is required to determine the possible similarities and differences between the endocast of Taung and those of *Homo* and *Pan*, it is evident that Taung will continue its position as one of the most important fossils in the hominin record.

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### Long-term site fidelity and reproductive success in female sifaka (*Propithecus verreauxi*) at Beza Mahafaly, Madagascar

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Site fidelity, the tendency of individuals to stay or return to previously established natal or breeding areas, has been observed in numerous vertebrates, including primates, although cross-generational studies of the fitness consequences of site fidelity are few. Potential selective advantages of site fidelity include increased survival and reproductive success of those individuals having intimate knowledge of local resource and predator distributions as well as the presence of suitable mates.

This study tested the proposition that female residence patterns in sifaka can be differentiated according to whether social groups exhibit long-term (anchor groups; 20+ yrs.) vs. short-term (non-anchor groups; ≤ 10 yrs.) site fidelity and that female reproductive success (i.e., infant survivorship) covaries with the number of reproductive females residing in these respective groups. We predicted that females residing in anchor groups would exhibit higher fitness levels than those residing in non-anchor groups. These predictions were tested in 34 matrilineal social groups residing within Parcel 1 at Beza Mahafaly, Madagascar. 27 years of female life history and spatial data revealed that the 21 and 13 social groups were anchor and non-anchor groups.

MWW/linear regression showed a significant effect of group on the number of reproductive females/natal females residing in anchor vs. non-anchor groups and on infant survivorship, with 2.5-fold higher rates of infant survivorship observed in anchor groups composed of multiple reproductive females/daughters vs. non-anchor groups containing a single reproductive female/daughter.

These findings provide important insights into how life history can inform spatial-temporal dynamics of primate/human populations and their fitness consequences.

### Hard Tissues maintain a record of whole body metabolism and enlighten the metabolomics of development and life history

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The science of physiological time is key to understanding the biological basis of life history. However, our knowledge of the chronobiological factors regulating integrated mammalian life histories remains completely naught. Recently, a biological timing mechanism, the Havers-Halberg oscillation (HHO), was shown to strongly associate with all mammalian organ/tissue/body mass and life history characteristics. Evidence for this mechanism comes from bone and tooth tissues that often store in their mineralized microstructures and chemistry a record of responses by their forming cells to systemic circadian and multidien metabolic rhythms, manifesting as periodic growth lines at specific intervals of whole days.

Among primates the multidien rhythm ranges from about 2 to 12 days, depending entirely upon a species' body size and life history matrix, suggesting a metabolic link with body mass. To characterize this rhythm we evaluated metabolic profiles of domestic swine from plasma samples regularly drawn over two weeks, subjecting them to chromatography coupled with mass spectrometry and analyzing the periodicities of their circulating metabolites. 49% of 228 metabolites conformed to the 5-day multidien rhythm of its enamel. The biological functions of these metabolites are rate of cellular proliferation, apoptosis, and the concentration of Ca<sup>2+</sup>. The overarching biological role of these functions converge upon the regulation of the pace at which body mass is increased. We thus conclude that multidien biological timing has been co-opted among some major mammalian taxa - e.g., Primates - to generate HHO rhythms that likely regulate adult body mass and through this mechanism their life histories.

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### Biocultural consequences of Spanish contact in the Lambayeque Valley region of northern Peru: Stable isotope and dental microwear analysis as indicators of diet, subsistence, and mobility

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This study utilizes stable isotope and dental microwear analysis to reconstruct subsistence patterns and the residential mobility of Muchik individuals interred at two sites: La Capilla Santa María Magdalena De Eten (CSMME) and La Capilla Del Niño Serranito (CNS), both located in the Lambayeque Valley region of northern Peru. Stratigraphic and archaeological evidence dates CNS to the Early Colonial Period (A.D. 1535-1620) and CSMME to the Middle/Late Colonial Period (A.D. 1620-1750), allowing for a diachronic perspective to compare changes in subsistence patterns between the Early and Middle/Late Colonial periods.

Overall diet (using δ<sup>13</sup>C) and residence (using δ<sup>18</sup>O) is compared between the populations. Isotopic data are characterized in both tooth enamel and bone for each individual, reflecting early- and late-life diet and residence. This intra-individual perspective permits consideration of changes not only between populations, but within individual lifetimes. Dental microwear analysis further completes the late-life dietary

picture of both populations. Stable isotope and dental microwear results reveal a greater reliance on C4 plant sources in the Early Colonial Period and the possible incorporation of more C3 plants in the Middle/Late Colonial Period. Varying degrees of change in individual diet is evidenced at both sites.  $\delta^{18}\text{O}$  data suggest shifting migration patterns, though results could be clouded by myriad ecological factors. These results underscore the importance of continued regional and temporal studies of colonial Peru.

#### **Morphometric analyses of maxillary and mandibular first molars of Pleistocene hominins**

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Dental morphology plays a significant role in examining taxonomic differences and creating phylogenetic hypotheses in hominins. This study uses Elliptical Fourier Function Analysis (EFFA) to investigate the shape of the occlusal surface of maxillary and mandibular first molars from hominins classified as *Australopithecus robustus*, *A. africanus*, *A. sediba*, *Homo* sp., and *H. erectus*. The digitization process involves creating two-dimensional bounded outlines of the occlusal surface of each tooth type via digital photographs and computing harmonics and amplitudes using EFFA. The EFFA results are used as variables in multivariate statistical analyses. Interspecific variation and, when samples sizes allow, intraspecific variation were assessed. The results suggest that significant overlap exists in the shape of the  $M_1$  across the sample of hominin teeth. The results also indicate different ranges of variation; *A. africanus* demonstrate the greatest amount of intraspecific variation while *H. erectus* have the least. Overlap also exists in the  $M_1$  shape of *A. robustus* and *A. africanus*. However, the *H. erectus* specimens do not overlap with either australopithecine. These results are probably due to the quadrangular  $M_1$  of *H. erectus* as opposed to the buccolingually expanded shape in the australopithecine sample; the buccolingual narrowing in *H. erectus* is likely the derived condition. The  $M_1$  of *A. africanus* exhibits more intraspecific variation than *A. robustus*. Thus, while the occlusal shape of the  $M_1$  likely exhibits more variation than has been suggested, the  $M_1$  morphology remains a useful tool to help define a species and establish phylogenetic relationships.

#### **Genetic modifiers of IVD expression and leucine oxidation on a positively selected haplotype in East Asians**

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Human phenotypic variation along with genome-wide analyses of selection both indicate that infectious disease, climate, and diet have exerted strong selective pressure on diverse human populations within the past 50,000 years. However, few examples exist of selection on genetic loci firmly linked to metabolic phenotypes and selective factors. Here we use overlap between positively selected genetic loci and loci that associate with gene expression and phenotype to find functional candidates for selection. This method captures genetic loci that impact phenotype through modulating gene expression. Then, we use *in vitro* experiments and haplotype analysis to study the metabolic significance of loci under selection. Specifically, we probe genetic variants associated with expression of isovaleryl-CoA dehydrogenase (IVD), a gene responsible for leucine catabolism, in a region under positive selection in East Asians. Leucine is an essential amino acid in the human diet, found at high concentrations in eggs and cheeses, as well as soy beans, originally domesticated in East Asia. These genetic variants also associate with leucine metabolite levels in the blood. We use luciferase reporter gene assays in relevant human cell lines to show that derived alleles, at 80% frequency in East Asians, drive a 2.5-fold increase in expression over ancestral alleles. We further explore how differences in IVD mRNA expression *in vitro* translate into IVD protein expression and activity, through quantifying its metabolite, 3-Methylcrotonyl-Coenzyme A. Our results are consistent with selection on a haplotype that increases efficiency of leucine oxidation in Asians.

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#### **Energy balance and stress responses correspond with individual participation by redbait monkeys in aggressive intergroup interactions**

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Contests among social groups potentially represent a collective action problem: if all group members share the spoils of battle but only a few incur the costs of fighting, why do participants tolerate free-riders and continue to provide a collective good? In a study of six groups of redbait monkeys (*Cercopithecus ascanius*) at the Ngogo site in Kibale National Park, Uganda, we tested the underlying assumption that a collective action problem is an inherent feature of intergroup conflicts. If a collective action

problem exists, we expected participants and defectors to experience the same benefits and differing costs during conflicts, measured as changes in energy balance and baseline cortisol levels, adjusted for C-peptide levels. We found that individuals were identifiable as either conditional participants or unconditional defectors. Conditional participants experienced large increases in energy balance during weeks with intergroup interactions, regardless of whether they actually participated or fed in the contested resource. Defectors experienced no such increase in energy balance. Cortisol levels for defectors and participants were reduced during weeks in which they did not participate in aggressive defense, and the levels for participants spiked when they did contribute to defense. These patterns indicate that defectors were likely prevented from participation by an energetic barrier and that participants not only reaped disproportionate energetic benefits, but also experience heightened costs in the form of exaggerated stress responses. The unequal distribution of energetic benefits indicates that no collective action problem exists in this species.

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#### **Quantifying Hominin Ecospace to reconstruct early hominin dispersal routes**

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Regional gaps in our knowledge of hominin distribution often reflect gaps in our functional and geographical knowledge of suitable living conditions of early hominins. We utilize the concepts of "range expansions", "Hominin Resource space" and, most significant here, "Hominin Ecospace" to reconstruct early hominin dispersal routes and thus identifying potential target regions for future palaeoanthropological field work.

Hominin Ecospace encompasses the biotic and abiotic environment of hominins, including climate, vegetation, fauna and landscape features. We identify resources, competitors and environmental conditions characterizing the specific ecospace of selected hominin taxa. Hominin dispersal may either be ecologically constrained by the distribution of suitable vs. unsuitable habitats or it may be restricted by topographic features like mountain ranges or sea straits. Ecological and topographical barriers likewise illustrate natural barriers for hominin dispersal.

Our case studies show that the concept of Hominin Ecospace is a powerful tool in



determining suitable regions for early hominin expansions and occurrences. In South Eastern Africa it led to the discovery of earliest Homo and Paranthropus lineages with significant implications for their palaeobiogeographical history. Based on our Ecospace model, proxies for hominin dispersal routes are inferred from the distribution of forests and mosaic landscapes in Southern Caucasus and from diversity structures of faunal communities in the Pleistocene of Southeastern Asia.

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### **The growing divide: emergent social inequality in San Pedro de Atacama during the Middle Horizon**

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The Middle Horizon (AD 500-1000) in the San Pedro de Atacama region is characterized by intensified agricultural practices, expanded trade with the Tiwanaku polity and other regional centers, and increased social complexity and inequality. However, it is not clear whether and how influences exerted by the Tiwanaku might have driven the emergence of social inequality. While there is consensus that Tiwanaku influence is associated with a period of general improvement in biological aspects of quality of life, the relationship between this improvement and local social stratification is only recently being explored. Here, we hypothesize that resource access varied according to affiliation with Tiwanaku. Therefore, the prevalence of different biological markers of diet, nutrition, and body use would vary according to individual associations with foreign material culture. Our sample includes 557 individuals from seven Middle Horizon local cemeteries. Analysis of mortuary goods and cranial vault modification were used to determine degree of affiliation with foreign cultures. Skeletal trauma, carious lesions, abscesses, and antemortem tooth loss were used as physiological stress markers. Individuals associated with Tiwanaku grave objects have a higher prevalence of trauma, but better oral health, which suggests that social inequality played a role in distribution of benefits associated with Tiwanaku influence. Advantages as a result of this association are possibly related to cultural buffers protecting individuals from poor oral health and/or providing preferential access to valuable resources. However, it is worth noting the higher prevalence of trauma, which may be associated with increased social tensions among emerging social hierarchization.

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### **Relatedness and Social Organization at the Ray Site (11BR104): A Biological Distance Analysis of a Middle Woodland Ridge Top Cemetery in the Illinois Valley**

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The Middle Woodland period (50BCE-400CE) in the Lower Illinois Valley is well known for its highly visible archaeological record, particularly the numerous mounds that line the valley's bluffs and the funerary remains entombed within them. Archaeologists often present Middle Woodland or "Hopewellian" monumentalism and mortuary practices as generally uniform practices across the region, usually centered on a ramp-and-tomb complex that occupies the central space of the mound. The Ray Site (11BR104), located near the confluence of the Illinois and La Moine Rivers in Brown County, IL, is unique in that it does not conform to archaeologists' expectations of Middle Woodland disposal practices. Though the site is contemporaneous with "classic Hopewell" mortuary sites, e.g. Gibson (11C5), Pete Klunk (11C4), the site lacks mounds, and individuals are buried linearly along the bluff, though clusters of burials are present.

Bioarchaeological investigations are one important way researchers have explored biological and social relationships between Middle Woodland communities in the Illinois Valley. In this study, we conduct a biological distance analysis of the Ray site in order to test hypotheses about within site variation, and the connection between genetic relatedness and regional mortuary practices. Our results indicate a level of biological diversity within the cemetery similar to other Lower Illinois Valley sites. Males were less biologically variable than females, a result similar to trends at other contemporaneous sites. Our results also support previous studies that suggest Ray represents a biologically distinct group compared to other populations in the Lower Illinois Valley.

### **African ape body mass prediction: New equations based on known-mass individuals**

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Several studies have constructed equations for estimating body mass in hominoids from skeletal dimensions. However, these have either used species mean body masses or a limited number of dimensions, and most have not included immature specimens. This study employs a variety of postcranial dimensions (bone lengths,

articular surface breadths, articular surface areas) from known-mass hominoids (n(adult)=51; n(immature)=21) to construct prediction equations from least squares regressions of log-transformed data. Scaling relationships are compared between different taxonomic groupings, and equations are evaluated for their applicability to older juveniles (M2 eruption or older). Results are also compared with those based on previous species means-based equations.

Body mass prediction using the new equations is relatively precise, with percent standard errors of estimate for the best predictors ranging between 15% and 20%. Articular breadths give the most precise estimates, and the femoral head performs better than the humeral head. Equations that combine all great apes (gorillas, chimpanzees, and orangutans) are very similar to those including only African apes, suggesting that they are applicable across all large-bodied nonhuman hominoids. Older juveniles generally follow the same scaling patterns as adults, and regression coefficients and %SEE's are similar between adult and pooled adult-juvenile samples, suggesting that the same equations can be used across this entire age range. Previous species mean-based equations work well in estimating body mass of *Pan* individuals in this sample, but underestimate body mass in *Gorilla*, possibly due to variation in body size between previous skeletal and body mass reference samples.

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### **The human glenoid morphology – a comparative cadaver based study**

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Change in the human shoulder girdle are of interest from an evolutionary and a clinical perspective. The aim of this study is to address sexual dimorphism of the glenoid in the light of earlier claims of no such dimorphism.

In an anatomical cadaver dissection study 26 cadavers from the institutional body donation program of the University of Zurich were investigated (14 female and 12 male, male average age 76.5 yrs, range 64-93 yrs, female average age 83.7 yrs, range 60-99 yrs). In



succession to the anatomical dissection, several measurements were taken with a caliper (the greatest length and breadth of the glenoid and the distance from the superior tubercle to the scapular notch).

We found an average glenoid height of 37 mm,  $\pm$  3.2 mm (range 31-45.5 mm) for males and 33.8 mm,  $\pm$  2.3 mm (range 28-38 mm) for females, an average width of 28.6 mm  $\pm$  3.3 mm (range 22.5-39 mm) for males and 25.5 mm  $\pm$  1.6 mm (range 22-29 mm) for females and a supraglenoid tubercle to the scapular notch distance of 37.6 mm  $\pm$  3.1 mm (range 32-46 mm) for males and 32.2 mm  $\pm$  2.8 mm (range 26-37 mm) for females.

These results are part of a larger study with the main focus on reverse total shoulder arthroplasty and the secure implantation of the baseplate with regard to the suprascapular nerve. We see indications of variation in shape and robusticity between the different sexes which are of relevance to anthropologists and comparative morphologists.

*Mäxi Foundation Switzerland*

#### High-throughput restriction site associated DNA sequencing (RAD-Seq) for genomic studies of primates using museum specimens

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Natural history collections represent unique samples of the biological past. However, natural postmortem processes and preservation methods fragment and damage DNA in museum specimens, making PCR amplification and Sanger sequencing difficult and prone to contamination. As a result, genetic studies using museum specimens have been restricted to less than 20 loci, and usually to just one, the mitochondrial genome. The advent of high-throughput DNA sequencers that require short stretches of DNA as template has made it possible to generate truly genomic datasets from museum specimens when museum specimen DNA quantity and quality is carefully determined.

We used a RAD-Seq approach to sequence ~55,000 loci (150-300bp each) in >10 African papionin museum specimens (skins and tissue associated with skeletons) from the American Museum of Natural History and the Field Museum of Natural History. Prior to library preparation, median concentration of museum-derived DNA was ~1-2 ng/ul (from 80ul total volume of eluted DNA) and 80% of fragments were <100bp long. In order to obtain sufficient

DNA >70bp for digestion and sequencing, we used roughly 300mg of rehydrated museum tissue per specimen. After sequencing on an Illumina HiSeq 2500 and bioinformatic filtering, the >80% of loci mapped to the rhesus genome with read depths of ~20x. The quality and quantity of SNP data obtained from museum specimens was quite similar to that obtained from high-quality sources such as fresh blood or tissue, and can be used for such purposes as phylogenetic inference and common population genomic analyses.

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#### Teeth versus bones: A review of biological age from dental development and long bone diaphyseal growth in subadult human remains

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Dental development and long bone diaphyseal growth can be used for estimates of age at death from subadult remains. Both methods are based on physiological age, which is time since fertilization. Physiological age can be calibrated with chronological age (i.e., time since birth) by analyses of reference populations with known age at death. Diaphyseal long bone growth was analyzed in five subadult populations. Two urban: the Georgian/Victorian Spitalfields Coffin-Plate Collection (n=78), for which age at death was known, and the medieval Gloucester Collection (n=34). Three rural: the medieval Norton Priory (n=11), the medieval Poulton Collection (n=169), and the English Civil War Collection of Abingdon (n=29). For the Spitalfields Collection, known chronological age was compared with diaphyseal lengths of the humeri, ulnae, radii, femora, tibiae, and fibulae. Diaphyseal lengths from the other collections were compared to the seriated developmental rank order of their dentition.

For all metrics, Spearman's rank correlation coefficients were high (Spitalfields,  $r_s = 0.980 - 0.999$ ; Gloucester,  $r_s = 0.833 - 0.999$ ; Abingdon,  $r_s = 0.771 - 0.999$ ) and significant ( $P < 0.001$ ). The small Norton Priory sample was compared to the Poulton Collection owing to chronology and geographic similarity. No significant differences were found and so they were combined (n=180), with similar results ( $r_s = 0.966 - 0.999$ ). Long both growth appears to be curvilinear, with accelerated growth rates early and again after puberty. These results confirm the reliability of using diaphyseal lengths as a method for developmental and therefore chronological age estimation in subadult remains.

#### What's inside tarsier faces?

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Tarsiers are one of the most important groups in our attempts to clarify primate phylogeny and evolution. However, their social behavior and communication remain incompletely understood. Facial muscles produce facial displays and provide important data in our understanding of social behavior and visual communication. The present study was designed to evaluate the gross and micro-anatomy of facial muscles in *Tarsius bancanus*, the western tarsier. This primate is largely nocturnal, arboreal, and directly interacts with conspecifics on a limited basis, primarily using long-distance modes of auditory and olfactory signals. Given these factors we hypothesized that facial musculature in tarsiers would be best developed in the region of the external ear (to move them in hearing) with relatively gracile muscles around the lips. Two adult female specimens were dissected and one was sectioned for histochemical procedures. As hypothesized, the facial muscles were well developed in the region of the external ear with relatively flat, undifferentiated muscles around the lips, resembling the arrangement seen in galagos. Microanatomical investigation revealed a thin band of orbicularis oris muscle that lacked multi-directional fibers seen in anthropoids. In addition, most of the upper lip thickness appeared to be occupied by loose connective tissue, unlike the condition in rhesus macaques and chimpanzees. These results are contrary to previous studies that investigated tarsier facial musculature but the differing methodologies may account for some of these differences. Further, these results support the observation that *T. bancanus* relies on long-distance social signals instead of proximate, visual signals such as facial expressions.

#### Morphological covariation between maxillary sinus shape and the midfacial skeleton

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Maxillary sinus volume has previously been shown to track ecogeographic differences in nasal cavity form. However, little is known about how maxillary sinus shape relates to overall facial morphology. Employing a total of 31 coordinate landmarks collected from digitally rendered crania, this study investigates how maxillary sinus and midfacial shape covary in a sample of modern humans from two climatic extremes: "hot/wet" (Sub-Saharan Africans; n = 34) and "cold/dry" (Siberian and Arctic; n = 37). Principal Components Analysis reveals clear discrimination between the two samples along

PC1, which contrasts “cold” individuals exhibiting relatively wider, taller sinuses and narrower, taller noses from “hot” individuals exhibiting relatively narrower, shorter sinuses and wider, shorter noses. A Two-Block Partial Least Squares (2B-PLS) test demonstrates moderate but significant covariation ( $RV = 0.32$ ,  $P < 0.001$ ) between the facial skeleton (block1) and maxillary sinus (block2). This 2B-PLS test again indicates that most of the covariation (49%) relates to the height/breadth of both the nasal cavity and maxillary sinus. While these results support previous arguments that maxillary sinus morphology relates to ecogeographic patterns of the nasal cavity, our study also reveals more nuanced relationships between the maxillary sinus and other aspects of facial morphology, such as maxillary body height and relative positioning of the zygomatic bone. Therefore, our results further suggest that the maxillary sinus serves as a zone of accommodation at the convergence of multiple facial components, potentially minimizing the morphological impacts of evolutionary alteration in one component (e.g., the nose) upon other aspects of the face.

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#### **Evolving to Eat: Food composition and human mandible morphology**

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Food composition influences numerous morphological changes in the human mandible related to mastication biomechanics. A wider ramus extends the moment arm of the masseter and temporalis muscle, whereas a robust mandibular body resists higher torsional loading associated with chewing harder tougher foods. Exploring how mandible morphology relates to food composition throughout human evolutionary history requires comparing skeletal population samples associated with multiple subsistence practices for evidence of morphological differences. This study tests the hypothesis that maximum mandibular ramus and body breadths are less robust in committed agriculturalists compared with earlier mixed subsistence forager-farmers by focusing on two population samples from the prehistoric Southwest U.S. Standard mandibular measurements were collected with sliding calipers, and population body size differences were considered with regression residuals. Statistical analyses including ANOVA and t-tests were calculated to compare maximum mandibular ramus and body breadth differences between the two population samples. Results indicate that mandibular ramus breadths were not significantly different or more variable in either population sample tested. Mandibular body

breadths were found to be significantly wider in the forager-farmer than in the committed agriculturalist population sample. These results provide partial support for the proposed hypothesis, and aid in defining the evolutionary history behind higher frequencies of contemporary dental diseases of disuse such as impacted third molars, malocclusion, and dental crowding associated with eating softer increasingly processed foods.

#### **Injuries, Impairments, and Intersecting Identities: The Poor in Buffalo, NY, 1851-1913**

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According to intersectional identity theory, age, gender, socio-economic status, ethnicity and physical impairment can ‘intersect’ to create unique and dynamic social identities. This theoretical stance is supported by historical and osteological evidence about the former residents of the Erie County Poorhouse, located in Buffalo, New York, which allow us to characterize their lived experiences. Thus, in the eyes of their late-19<sup>th</sup> to early 20<sup>th</sup> century, rapidly urbanizing society, although poorhouse “inmates” were generally considered “undeserving poor,” individual identities were construed through the complex interaction of multiple facets of their identities. For example, annual reports generated by the Erie County Hospital, which was responsible for treating county residents who could not afford private care, indicate that males were ten-times more likely to be treated for traumatic injuries than females. Similar demographic trends were observed in the skeletal sample recovered during recent salvage excavations at the former Erie County Poorhouse Cemetery. Skeletal analysis of a sample of 207 adults, whose appendicular skeletons were at least 75% complete, indicates that middle-to-old adults had almost twice as many observable appendicular traumatic injuries as young adults. This pattern was especially pronounced among females. Similar demographic trends were also observed when, using clinical literature as a guide, physical impairment severity was assessed. These findings suggest that the constituent elements of their social identities predisposed individuals to differential risk of sustaining traumatic injuries and associated physical impairments. Physical impairments, in turn, may have variously reinforced or otherwise altered their perceived social identities.

#### **Infanticide pressure and group size affect natal coat development in wild *Colobus vellerosus* at Boabeng-Fiema Monkey Sanctuary, Ghana**

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Infants in several primates are born with a distinct natal coat. Anecdotal reports suggest that infants may transition from natal coats to the adult pelage at varying rates. We investigated whether inter-individual variation in the duration of natal coat transitions is best explained by group differences in the intensity of scramble feeding competition or infanticide pressure. From 2008-2013, we collected demographic data on nine *Colobus vellerosus* groups that varied in composition. We recorded the number of days infants took to transition from white to grey (N=29) and from white to black-and-white (N=35). Using GEE, we investigated whether durations varied according to group size, infant sex, and adult male group composition. Infants in larger groups transitioned from white to grey later than infants in smaller groups ( $p=0.013$ ), but this effect dissipated later in development (white to black-and-white:  $p=0.506$ ). Infant males transitioned earlier than females (white to grey:  $p=0.000$ ; white to black-and-white:  $p=0.003$ ), perhaps because infanticidal males target male infants more than female infants. Infants in multi-male groups transitioned earlier than infants in uni-male groups (white to grey:  $p=0.000$ ; white to black-and-white:  $p=0.006$ ), possibly due to multi-male groups containing lesser-quality males with unstable dominance relationships, which increases infanticide pressure. Lower maternal energetic net gains due to higher feeding competition in larger groups may inhibit early infant development, but variation in natal coat transitions was best explained by the infanticide pressure hypothesis. Our results suggest that the threat of infanticide ultimately shapes infant development in *C. vellerosus*.

#### **The Impact of Local Mate Exchange and Founder Effects on Global Patterns of Mitochondrial Genomic Variation**

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While recent studies have demonstrated that global patterns of human autosomal variation have been shaped by serial founder effects, the extent to which this and other processes have shaped mitochondrial diversity is as yet unresolved. Here we focus on mitochondrial genomic variation to illuminate the role of maternally mediated gene flow and founder effects on global patterns of variation. We examined the correlation between gene identities in 248 globally distributed populations versus geographic distance from a potential East African founder location, and used a generalized hierarchical modeling framework to identify the root location of population trees and to test the fit

of the serial founder process to the genetic data. We used partial Mantel tests of gene identity, genetic structure, and geographic distance to identify the independent effects of gene flow and founder effects among populations. Results are then compared to those obtained from autosomal STR data.

The best fitting mitochondrial tree was rooted in East Africa. Gene identities increased with increasing geographic distance from the root location, though the correlation was weak and variation within global regions deviated significantly from the pattern predicted by a strict serial founder process. Additionally, gene flow played a stronger role relative to founder effects in shaping patterns of diversity. We show that incongruences between mitochondrial and autosomal data sets reflect differences in information content, effective sizes, and sex-biased gene flow. We explore the implications of these results for reconstructions of past demography.

#### **Migration and the Greater Context: Where to now?**

ALYSON C. CAINE and HEIDI A. SHAW.  
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Mobility and migration have long been recognized as important aspects of human behavior. Identifying migration in the archaeological record has proven difficult and only recently been reinvigorated through the application of new and unique methods, notably stable isotope analyses. As a result, there has been a surge in the literature over the past twenty years of studies positively identifying migrants in the archaeological record using stable isotope analyses, proving the reliability of these methods. Researchers are now able to begin integrating isotope analysis results into the larger framework of migration studies in archaeology. Specifically, a prevailing theme of migration studies is the influence that mobility and migration have to the prevalence and transmission of disease. However, the same problem in interpreting the data has occurred; it is difficult to account for the effect of migration on health in the past without conclusive evidence of migration. The ultimate research goals of isotope migration studies, however, are rarely addressed in the literature, which is problematic for understanding the archaeological significance of this body of research. This survey of migration studies aims to highlight the methods utilized and address applicability and limitations to migration studies.

In this presentation, we present an in depth review of the current published literature for migration studies using stable isotope analyses. We address the effectiveness of these studies and their contribution to the bioarchaeological research theme of health. Limitations to the methods as well as areas of improvement will be

addressed to suggest directions for future research.

#### **Y chromosome in surname samples: Insights into surname origin and frequency**

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The biological behavior of the Y chromosome implies that males sharing the same surname may also share a similar Y chromosome. However, socio-cultural factors, such as polyphyly, non-paternity, adoption or matrilineal surname transmission, may disconnect transmission of the surname and from that of the Y chromosome. By genotyping 17 Y-STRs and 68 SNPs in ~2,500 male samples that carried one of 50 selected Catalan surnames we could determine sets of descendants of a common ancestor, the population of origin of the common ancestor, and the date when such a common ancestor lived. Surname frequency was positively correlated with haplotype diversity, that is, rarer surnames showed the strongest signals of coancestry. Introgression rates of Y chromosomes into a surname by non-paternity, adoption, and transmission of the maternal surname were estimated at 1.7% -2.9% per generation, with some local variation. Average ages for the founders of the surnames were estimated at ~450 years, suggesting a delay between the origin of surnames (12th-13th centuries) and the systematization of their paternal transmission. Finally, we estimate that surname prediction from a Y-chromosome haplotype, which may have interesting forensic applications, has a ~60% sensitivity but a 17% false discovery rate, and that in some cases of mispredicted surnames, the ancestors of the proband may have carried the predicted surname.

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#### **Multifaceted data collection to interpret aetiology of joint osteoarthritis in the human skeleton**

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Osteoarthritis (OA) is the most common joint disease in human populations with onset and severity influenced by mechanical loading, aging effects, genetics, anatomy, and body mass. As a result, OA generally presents as hypertrophic changes at articular surfaces of synovial joints, but its pathogenesis remains unclear. Understanding the patterning of OA is important to recognize inherent complexities of the disease,

but further research is also necessary to understand the role of physical activity and features of osseous change. The multifactorial aetiology of OA requires the incorporation of multiple lines of evidence to interpret individual or population health from bone samples.

Varied approaches to data collection present a number of challenges and benefits. While the challenges include aspects such as statistical design involving diverse data types, one of the most important benefits of integrating different datasets is the ability to address questions that underlie previous assumptions about how to interpret OA in the human skeleton, and to test those assumptions. For example, combining long bone 3D surface laser scans with documented occupational categories allows us to test the assumption that occupation categories reflect activity (e.g. mechanical loading levels). Examining the relationship between activity and joint OA affords us a contextually specific biocultural lens into the past. Bioarchaeology is a comparative science and research methods of OA must draw upon data from the analysis of several sources to evaluate the complex interactive process between humans and their social, cultural and physical worlds.

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#### **How many in the tomb of Tiy? Calculating the number of individuals interred in a Nubian 18<sup>th</sup> Dynasty pyramid tomb from Tombos, Sudan**

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The Egyptian colonialization in Nubia during the New Kingdom period (1500-1050 BC) is marked by the utilization of Egyptian mortuary practices, such as pyramid tombs, by immigrant Egyptian and Egyptianized Nubian elite. One such example of a pyramid tomb comes from excavations at Tombos, Sudan, at the 3<sup>rd</sup> Cataract of the Nile River. The tomb contains the mostly articulated skeletal remains of a single individual, the commingled remains of a number of other individuals, as well as numerous artifacts, such as an incense burner, four canopic jar heads, and funerary cones, an artifact strongly associated with Egyptian tradition from the capital at Thebes. Other associated artifacts included an inscribed *ushabti* figurine, which identified the mostly articulated skeleton as the tomb owner, 'Tiy.' Excavation in the tomb began in 1991 by the University of Khartoum and was continued in 2011 by the UCSB-Purdue team. A preliminary minimum number of individuals (MNI) of 32 was calculated. This study examines the feasibility of widely used bioarchaeological and forensic methods for calculating MNI and



## AAPA Abstracts

most likely number of individuals (MLNI) on highly fragmented remains. Additionally, effects of taphonomic conditions on these calculations are considered with respect to the lengthy time span between the initial and final excavations.

**Sample condition and fecal steroids: An association between water content and assay values**

JOSEPH CALIFF. Princeton Writing Program, Princeton University.

Fecal sampling facilitates non-invasive assessment of physiological data from wild and captive animals. Sample condition (e.g., water content) upon collection may influence variation in hormone assay values (or, perhaps, be influenced by the hormones in question), yet previous studies have not investigated this possibility. To test for effects related to sample condition, 147 fecal samples were collected from captive male baboons (*Papio* sp.) fed a standardized diet. Samples were scored on a five-point scale corresponding to their estimated water content upon collection. Fecal testosterone (fT) and glucocorticoid (fGC) levels among the five groups were compared using ANOVA. The fGC values show a significant positive relationship with water content ( $F(4, 142) = 6.917, p < 0.001$ ) and fT values follow this same trend ( $F(4, 142) = 2.016, p = 0.095$ ). Whether high water content influences assay values or high circulating GC (stress) levels increase fecal water content, future research might focus on how sample condition, intestinal passage time, and gut microbiomes affect measurement of physiological markers of stress and other endocrine correlates.

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**Body size and shape variation among southern African Later Stone Age herder-foragers**

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Later Stone Age (LSA) forager skeletons from the southern African Cape coast are small-bodied in terms of stature, body mass, and body breadth. Body size variation has not been extensively considered for prehistoric to early historic individuals from the sparse and semi-arid central interior of southern Africa. These individuals participated in both herding and foraging, however, previous studies suggest that their subsistence practices were similar to coastal

foragers, and that both groups shared craniometric characteristics (Morris, 1984). This study compares the body sizes of coastal LSA foragers ( $n = 37$  men, 28 women, 1 unassigned) to herder-foragers from the central interior ( $n = 25$  men, 32 women, 8 unassigned) to assess if the small-bodied phenotype observed on the coast appears amongst the central interior individuals.

Maximum femur length (MFL), maximum femoral head diameter (MFHD) and bi-iliac breadth (BIB) were compared between the coastal and central interior samples. There are no significant differences in MFL, MFHD, or BIB between the two samples: stature, body mass, and body breadth are similar in these groups. There are, however, differences in sexual dimorphism between the two samples. Coastal LSA men and women have significantly different MFL and MFHD, however only MFHD is significantly different between central interior men and women. There is no difference in BIB between the sexes within either group, however sample sizes are small. Central interior herder-foragers share the small-bodied phenotype of coastal LSA samples, however body size sexual dimorphism may be affected by ecological factors and environmental resource availability.

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**Articulation area, robusticity and body mass effects on age-related traits from the pubic symphysis, iliac auricular surface and acetabulum**

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Since the beginning of the 20<sup>th</sup> century methods have been developed for estimating age at death from the metamorphosis of the *os coxae* articulations. The unreliability of these methods has been recognised and it has been proposed that their inaccuracy may be caused by a changing ratio of environmental and genetic factors affecting bone degeneration. However little is known about the real effect some factors have on bone metamorphosis and how this may affect age estimation. The main objective of the present research is to determine if skeletal robusticity, body weight, stature, and articulation size affect age-related modifications at the pubic symphysis, iliac auricular surface and acetabulum, in female and male individuals from the Coimbra and William Bass Donated Skeletal

collections. Three approaches of measuring degeneration were studied: individual traits, components (weighted linear combinations of traits) and composite score (sum of all the scores across all traits). A Wilcoxon test demonstrates some of the traits have a significant asymmetry, and therefore, only the left side data were analysed. The rank correlation between age and degenerative criteria ranges from low to high, suggesting that other factors, besides age, may affect the degeneration of the *os coxae* joints. Logistic regression analysis indicates that some, but not all, degenerative criteria are affected by body size variables, with different patterns between population samples. Possibly the dissimilarities encountered between samples may be due to, body mass and age distribution differences between populations, or due to a random effect of body size variables in bone degeneration.

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**Creating a Standardized Methodology for Recording Trauma in Human Skeletal Remains**

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Despite the fact that skeletal trauma is regularly recorded in archaeological and forensic contexts, methods and formats for describing and recording trauma seem to be nearly as numerous as the scholars who apply these methods. This paper attempts to rectify this issue by creating a standardized methodology and recording form for describing and analyzing trauma in human skeletal remains. Modeled after the tested and accepted format of Buikstra and Ubelaker's (1994) *Standards for Data Collection from Human Skeletal Remains*, and drawing on trauma analysis techniques from bioarchaeological and forensic literature, this new methodology and recording form are designed to be of use to both forensic anthropologists and bioarchaeologists. The form is accompanied by clear, detailed instructions and numerous diagrams and descriptions, as a way to decrease intra- and inter-observer error. It is also intended to aid in the reconstruction of the original circumstances surrounding the trauma.

Professional feedback was considered in the creation of the new data collection form to ensure comprehensibility and simplicity. It is hoped that the resulting methodology and recording form will be not only be useful to bioarchaeologists and forensic anthropologists, but to students and professionals alike. Perhaps most importantly, this form is intended to standardize data collection for traumatic injuries in human skeletal remains in order to promote more objective analyses and enable more



effective comparative studies and meta-analyses in the future.

### Occlusopalatal Landmark Variation among Savanna Baboons Fed Different Diets

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Variation in occlusopalatal skeletal development has been linked to multiple factors including the functional demands placed on these elements during ontogeny. Previous research indicates strong relationships between dietary consistency (soft versus hard foods) and variation in dental occlusion and palate shape. Our previous research indicated shorter and more variable palates among savanna baboons fed soft foods, but the relative position of the palate and other details of the variation in shape remain unclear. To help clarify this issue, we collected 3D landmark data to test the hypothesis that among savanna baboons a softer diet results in a palate that is shorter and more variable in its position. Here, we examined 22 landmarks from the palate, basicranium, and face in two samples of savanna baboons fed diets with different dietary consistencies (n=49). To explore variation in landmark position, we performed principal component analysis on Procrustes transformed coordinates. Results indicate that the greatest variation between groups exists in the positions of basion, hormion, and nasion, rather than in the position of the palatal landmarks themselves. Angles representing degrees of flexion at these locations were also found to be significantly different between groups. The position of these landmarks suggests less basicranial flexion around the naso- and oropharynx in the soft diet sample, with this group having more anteriorly located palates relative to the basicranium and airways that are flattened relative to the Frankfurt plane. The functional and taxonomic implications of these findings are discussed.

### Local and global climate effects on white-faced capuchin population growth and demography

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Long-term monitoring is necessary for understanding the extent to which primate populations can cope with the localized effects of global climate change. We investigated how local rainfall patterns in a Costa Rican dry forest varied in response to the El Niño–Southern Oscillation (ENSO), and we analyzed how these shifting climate conditions affected the population dynamics of white-faced capuchins (*Cebus capucinus*) over a 30-year period using repeated censuses. Rainfall patterns were

strongly coupled with phases and intensity conditions of the ENSO. The most severe dry periods—which occurred during the 1980s and 1990s—coincided with unusually intense El Niño phases and were associated with decreases in population growth rate, mean group size, and reproductive rate. El Niño phases caused two notable rainfall deficits: 1) during the critical dry-to-wet season transition, a time of severe water stress; and 2) during the peak of the normal wet season, which is usually the peak of fruit abundance. Rainfall patterns showed an increasing trend since the mid-1990s in conjunction with an ENSO regime dominated by frequent La Niña phases. The population's immature-to-female ratio (as a measure of reproductive rate) was best predicted by a rolling mean index of ENSO conditions of the 3 years prior to the census year. Predictive models of reproductive rate based on ENSO activity were superior to those based on local rainfall. The sensitivity of this ecosystem to global climatic phenomena suggests an emerging conservation concern if drought years become increasingly common as the global climate warms.

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### Variation in Functional Regulatory Sequences and Evolution of the Primate Elbow Joint

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The patterning and morphogenesis of the skeletal system is a highly regulated process, which begins in the early embryo and continues throughout adulthood. Synovial joints are key components of this system as they permit bones to undergo complex movements during locomotion and positional behavior. Not surprisingly, primates show tremendous variation in synovial joint morphology. Interestingly, many of the observed differences in elbow joint morphology between apes and Old World monkeys are apparent during early infancy indicating that they are, in part, under the regulatory control of developmentally important genes. The *Growth and differentiation factor 5* (*Gdf5*) is one such gene, which is expressed *in utero* during joint development, and is required for normal joint formation and maintenance. We previously revealed numerous, highly modular *Gdf5* cis-regulatory enhancers capable of controlling expression at unique joint sites during development. Here, we reveal individual transcription factor (TF) binding site motifs within distinct regulatory enhancers, whose

experimental disruption highlights joint-specific control at the DNA base-pair level. By surveying in primates the sequence composition of these regulatory enhancers in the context of TF binding we provide evidence for multiple clade-specific evolutionary mutations that may underlie the characteristic elbow morphological differences between apes and Old World monkeys. Surprisingly, an examination of these mutations at the TF motif level reveals that each disrupts the experimental binding of IRX2, a transcription factor expressed in joints. These data suggest that developmentally expressed TF modules at cooperative functional regulatory elements may be targets of evolutionary change.

### Ear removal: Skeletal evidence for trophy taking in the prehistoric Mississippian Midwest

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Trophy taking and ritualized violence during the Mississippian period, resulting in the removal of scalps, heads, hands, and forearms, has been well documented at Cahokia and peripheral sites. The authors present the first known skeletal evidence for ear removal in pre-European Illinois and Wisconsin. Two individuals, one from the East St. Louis site in Illinois and one from the Aztalan site in Wisconsin, show possible evidence of ear removal, as indicated by cut marks on the temporals near the external auditory meatus and on the mastoid process. The cut marks are too inferior to be associated with scalping styles found at Mississippian sites and do not resemble other modifications seen on individuals from these sites. The East St. Louis individual is an old adult female buried in a prone position while all the individuals interred nearby were supine. The Aztalan individual is represented by an isolated temporal bone recovered from the midden area at the site and is associated with other individuals that show a range of perimortem trauma. Neither individual shows signs of healing, indicating the ears were removed at or around the time of death. This poster highlights trophy ears as a formerly undocumented trophy taking practice amongst Midwestern Mississippians. This practice may have been more common than previously recognized, since the identification of cut marks indicative of ear removal is dependent upon the recovery of well-preserved crania, close inspection of remains, and skeletal evidence of an activity that could be easily performed without leaving a mark.

### Resource Use by Aye-Ayes in Small Forest Fragments in Eastern Madagascar

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Aye-ayes (*Daubentonia madagascariensis*), elusive but widespread in Madagascar, are known for their ability to live in close proximity to humans. At the high altitude site of Tsinjoarivo (east-central Madagascar, 19.7°S, 47.8°E), aye-ayes have been camera-trapped and their feeding traces regularly observed in small forest fragments near primary continuous forest. They presumably cross between fragments, exploiting grubs of wood-boring insects. Understanding the degree to which they compete for resources with humans is of critical importance to their continued survival in such habitats. Both humans and aye-ayes use dead trees; humans for firewood and aye-ayes for grub extraction.

We documented aye-aye feeding traces in the forest fragments at Tsinjoarivo from June 11-23 2014, using two transect samples in which we identified tree species, and measured and estimated their time since death. In a larger sample (10 meters left and right of trail), we found 316 aye-aye feeding traces on 29 species of tree and 1 species of bamboo, all of which indicated grub extraction. Trees had an average diameter of 13.96cm, and an average estimated age since death of 9.04 years. In a smaller sample (5 meters right of trail), we recorded all dead trees and traces of both aye-ayes and humans. Both aye-ayes and humans are selective in their use of dead trees; they did not use them randomly with respect to tree occurrence. Importantly, trees used by Malagasy were not preferred by aye-ayes, indicating that Malagasy people and aye-ayes may not be competing for use of the same tree species.

### A bioarchaeological exploration of scorbutic cranial lesions and a proposed etiology

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The development of scurvy is a result of a Vitamin C deficiency, usually attributed to a poor diet and genetics. Because Vitamin C is necessary for collagen synthesis and production of strong blood vessel walls, a deficiency results in porosity in several areas of the skull, e.g., eye orbits, mandible and sphenoid. It is suggested that scorbutic effects on the cranium can manifest other than as small porosities or porotic hyperostosis, and lesions can also develop on the parietals, occasionally extending onto the sphenoids.

Most cases of scurvy occur in juveniles, but it is argued, however, that the condition is evident in adult crania from several collections in Great Britain, South America, and the United States. In these cases, lesions are symmetrical and vary in size and number. It is hypothesized that their formation is a result of the pull of the temporal fascia on the *galea aponeurotica* as a result of normal use of *M. temporalis*, with orientation of these lesions providing evidence. Ortner and Erickson (1997) established that lesions do manifest in the region of the temporal muscle as a result of hemorrhaging occurring as the muscle is used, but it is not clear if they appear as these 'combed hair' lesions.

In addition to these lesions and small patches of porosity, a series of atypical larger striated porous lesions and pitting is noted, which may result from angiogenesis occurring under the *galea aponeurotica* as opposed to porotic hyperostosis. All of these factors support an etiology of scurvy.

### Estimation and comparison of the adult cranial morphology of *Australopithecus sediba* using developmental simulation

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One of the primary criticisms regarding morphological interpretations of *Australopithecus sediba* relates to the juvenile status of the MH1 type specimen. Some have argued that future developmental change between MH1's current stage of development (second molars erupted and in occlusion) and full adulthood might be substantial enough to alter current interpretations concerning the phylogenetic relationships of this species. The present study uses geometric morphometric techniques to address these concerns through developmental simulation. Landmark-based developmental vectors derived from 3D laser scans of chimpanzees (*Pan troglodytes*), gorillas (*Gorilla gorilla*), and humans (*Homo sapiens*) were separated by sex and applied to a synchrotron scan of the MH1 cranium to produce virtual renderings of the simulated adult cranial morphology. In order to understand the morphological similarities of these generated adults in a broader comparative context, multivariate tests were carried out using a sample of non-robust hominin crania. The developmental changes simulated to occur appear to be strongly related to the onset of puberty and are dependent upon the relative degree of sexual dimorphism inherent in the

extant species vector applied. Further, multivariate tests indicated that all simulated adult *Au. sediba* crania remained more similar to one another than to any other hominin species included in the analysis. Upon reviewing the results of the present study, it is reasonable to conclude that the morphological changes expected to occur between second and third molar eruption in the MH1 cranium are unlikely to impact interpretations of this fossil and its morphological affinities as presented in the announcement.

### Cortical structure of hallucal metatarsals and inferring foot loading in early *Homo*

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Loading experienced by modern human feet differs substantially from that of other apes, likely reflecting different foot configurations (e.g., adducted versus abducted hallux) and weight transfer mechanisms. Internal structure of hallucal metatarsal diaphyses presumably reflects these differences in loading history. By applying a recently demonstrated morphological approach for visualizing and quantifying continuous cortical bone properties of diaphyses, we compare internal structure of hallucal metatarsals from apes and two Dmanisi individuals. Specifically, we test whether Dmanisi first metatarsals exhibit modern human patterns of cortical bone distribution, or whether these human patterns emerged more recently. For each hallucal metatarsal, 17 cross sections were extracted at regularly-spaced intervals between 25% and 65% mechanical length. Cortical thicknesses in cross sections were measured in one degree radially-arranged increments, while second moments of area (SMAs) and section moduli (SMs) were measured about neutral axes in one degree radially-arranged increments. Standardized thicknesses, SMAs, and SMs were visualized using false color maps, while penalized discriminant analyses were used to evaluate group differences. Overall, Dmanisi hallucal metatarsals exhibit ape-like levels of thickness. Although Dmanisi specimens themselves differ in thickness distributions, visualized patterns in thicknesses are neither human-like nor ape-like. Comparisons of continuous SMAs and SMs indicate that Dmanisi hallucal metatarsals are uniquely reinforced compared to apes, but are most like humans and australopithecids (e.g., StW562 and SKX5017). Modern human loading patterns experienced by hallucal metatarsals appear to have not yet fully

emerged in Dmanisi hominins, possibly also implying the existence of a difference in toe off.

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#### **A phylogenetic hypothesis of fossil colobine relationships**

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The evolutionary history of the Colobinae has remained largely unknown, because despite advances in molecular phylogenetics, parsimony analyses of colobine phylogeny based on morphology are rare, leading to difficulties discerning the relationships among fossil colobines. Species of this group exhibit geographical ranges, dietary preferences, and locomotor adaptations unparalleled in their extant relatives. However without a robust phylogenetic framework, informed character-based hypotheses about the evolution of folivory and arboreality in this group are nearly impossible to formulate. Researchers are able to comment on the adaptive responses of individual fossil species, but the potential links between living and fossil taxa have yet to be tested within a strictly cladistic framework. To assess the phylogenetic relationships within the Colobinae, over 300 morphological characters were scored for nearly all fossil genera and 88% of living species.

Parsimony and Bayesian analyses utilizing a variety of coding methods suggest that majority of the African taxa, such as *Rhinocolobus* and *Cercopithecoides*, are more closely related to the living Asian colobines, based primarily on nasal and dental morphology. *Mesopithecus* was nested within the odd-nosed group, while *Dolichopithecus* was supported as a stem Asian colobine. These phylogenetic placements provide a foundation for biogeographic hypotheses about colobine dispersal or theories about the mechanisms of pollical reduction. Additionally, as fossil colobines represent a significant part of the Neogene catarrhine community in Africa, an improved understanding of the adaptive shifts that characterized colobine evolution may also shed light on the ecological context of the hominins that lived alongside them.

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#### **Estimated body parameters of the Sima de los Huesos hominins**

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One of the most widely discussed aspect of postcranial morphology that is relevant to the entire evolution of our genus, and to the origin of modern humans, *Homo sapiens*, involves differences in body size, body shape and body proportions between early *Homo* species, Neanderthals and early modern humans.

The Sima de los Huesos Site, with bone remains belonging to at least 28 individuals of the Middle Pleistocene, gives us the opportunity to explore some body parameters in a pre-Late Pleistocene homogenous fossil population.

A great variety of skeletal features can be discussed in relation to the evolution of human body, but here we discuss only some of those that can be explored in long bones and pelvic remains from SH sample such as the body breadth, body mass, stature, articular proportions, intra-limb proportions (brachial and crural index), shaft geometrical properties, bone volume and skeletal weight.

To investigate brachial and crural indices we propose some associations between different limb bones (six for the forelimb and one for the hindlimb). With the associations, stature derived from multivariate equations can be also estimated. Finally we pay attention to the incidence that bone volume (calculated via CT-scan) can have in our body mass estimates.

Up to now, our findings show broad, heavy, mid-stature bodied hominids with variable articular dimension, robust, thick and heavier long bones, brachial and crural indices similar to those of recent Mediterranean Europeans and recent Euroamericans.

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#### **An Enigma in the Wisdom: Puzzling through Predictors of Third Molar Agenesis**

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Impacted or absent third molars have existed in the human fossil record since at least *Homo*

*erectus* and are extremely common in modern humans. However, the existing literature on modern predictors of agenesis, while rich, is highly contradictory. Thus, to investigate sex, population, and morphological predictors of agenesis we conducted a meta-analysis of previously published papers (n=80). A meta-analysis takes into account the effect size and sample size of previously published papers, by first deriving an overall effect size and then estimating which factors lead to variability in results among different authors. Across all populations (n=7), we found a worldwide rate of agenesis of 21.95%. Differences between maxillary and mandibular agenesis were found (mandibular > maxillary; p=0.0059) and individuals were more likely to have 1 or 2 third molars missing than 3 or 4 third molars missing (p<0.0001). Males and females were equally likely to exhibit agenesis, but we found support for population-level differences in agenesis prevalence (p<0.0001). Therefore, we re-evaluated sex and maxillary/mandibular differences by population. Our results indicate that third molar agenesis manifests differently across populations, suggesting that the genetic mechanism or selective regime behind agenesis may also differ among populations. Analyzing the evolutionary context of these dental features should help both our understanding of the biological changes that occurred during major transitions in human diet and inform clinical practice in third molar treatment for millions of Americans annually.

#### **Cranial deformation in an Ohio River Valley Adena Population**

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Cranial deformation has been documented in many different cultures and over thousands of years. Researchers divide deformed crania into two categories: those exhibiting intentional (artificial) deformation, in which force is applied to an infant's cranium to control growth in a given direction, and unintentional deformation, wherein deformation occurs as a result of inadvertent factors, such as cradleboarding. Cradleboarding is common in the Americas, having been documented among many different groups, including the Adena. The Adena are widely known for exhibiting cranial deformation; 92% of all Adena skulls exhibit either bilateral or unilateral occipital flattening as a result of cradleboarding. Here we describe the cranial deformation present in a relatively unstudied Adena population of the Ohio River valley. The Galbreath Mound, excavated in 1975, dates to between approximately 1,945 and 2,300 BP. Of 44 individuals excavated, 9 crania were in good condition to be reconstructed and assessed for antero-posterior deformation; crania exhibit flattening of the occipital bone and lateral compensation in the parietals, which are



characteristics of deformation as a result of cradleboarding. This study adds another skeletal population to the assemblage of known Adena skulls exhibiting cranial deformation due to cradleboarding. Future research will address masticatory function and tooth wear as a result of cradleboarding in this population.

**Lurking in the genes: A case study of reactive arthropathy in comparison to other HLA-B27 related conditions and DISH**

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During the 2014 Texas Tech University anthropological field school in Nicosia, Cyprus; a female geriatrician from the St. Nicholas cemetery in Limassol showed definitive evidence of having severe reactive arthropathy (Reiter's syndrome). The individual exhibited lesions specific to fusion of the thoracic and lumbar spinal column primarily along the posterior aspect of the spine with no intervertebral fusion. There were additional fusions observed at the sacroiliac joint, at the left femoral head and acetabulum. We also observed severe Lanois deformity with no corresponding fusion or arthritis mutilans of the hands. Lanois deformity is characterized by a fusion of foot bones in a claw-like orientation. The overall lesion pattern of this individual suggest that reactive arthropathy is the likely origin of these lesions and not the more common HLA-B27 related seronegative spondyloarthropathies such as ankylosing spondylitis, psoriatic arthropathy, or enteropathic arthropathy. Although an individual with HLA-B27 might live unaffected and void of joint lesions, reactive arthropathy can be induced at any time via common bacterial infections. This rare example of such a severe case of reactive arthropathy exemplifies how seronegative spondyloarthropathies might be differentiated from other HLA-B27 conditions via skeletal lesion patterns. We illustrate the uniqueness of this condition by comparing the lesions from individuals from the same sample with DISH and Ankylosing Spondylitis.

**The Shuar Health and Life History Project: Testing the Hygiene Hypothesis—Soil-transmitted helminth infection and immune dysregulation among the Shuar of Amazonian Ecuador**

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The Hygiene Hypothesis (HH) posits that increased prevalence of allergy/autoimmunity in economically developed nations stems from low levels of infectious disease exposure, particularly helminths. This decreased stimulation during immune development is hypothesized to result in greater inflammatory responses to later infections, as well as to harmless/self-produced stimuli. If correct, then: 1) lower helminth infection rates/intensities should be associated with greater integration into market-based economies (market integration, MI); and 2) higher inflammation in response to helminth infection should be associated with greater MI. This study tests these hypotheses among 457 Shuar of Amazonian Ecuador (ages <1 to 100) experiencing three levels of MI: 1) more traditionally-living communities from east of the Cutucu mountains (CC; N=239); 2) moderately-integrated communities from the Upano Valley (UV; N=166); and 3) highly-integrated individuals from the town of Sucúa (S; N=52). Analyses of stool samples indicate that 57%, 61%, and 71% of CC, UV, and Sucúa individuals, respectively, were infected with at least one type of helminth. CC individuals had significantly higher roundworm intensities than UV individuals ( $P < 0.05$ ). Sucúa individuals had significantly higher whipworm intensities than UV individuals ( $P = 0.05$ ). Preliminary analyses of dried blood spot measures of inflammatory marker C-reactive protein (CRP) among children (ages <1 to 18) found no differences between CC and UV communities based on infection. This preliminary study found no evidence for the HH at these levels of MI. Further analyses will explore CRP in adults and children, and analyze specific markers of MI in relation to helminth infection and immune dysregulation.

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**Potential False Negatives: A Preliminary Analysis of Non-Diagnoses for Pulmonary Tuberculosis Based on Non-Observation of Inflammatory Rib Lesions**

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Prior research has often suggested that the best diagnostic criteria for pulmonary tuberculosis in skeletal remains are the presence of rib lesions. However, it is possible that individuals suffering from pulmonary tuberculosis do not present with such lesions. Indeed, individuals clinically diagnosed with pulmonary tuberculosis may exhibit lesions in the vertebrae or other regions but not in the ribs. Therefore, while inflammatory rib lesions may imply pulmonary tuberculosis, they are neither conclusive nor always present in afflicted individuals.

This study tests the possibility that while rib lesions remain the leading way to identify pulmonary tuberculosis in skeletal remains, other periostitic and osteolytic activity should be assessed before ruling out possible pulmonary tuberculosis. Macroscopic assessment of known age and sex adult skeletal remains (n=125) diagnosed with tuberculosis was completed at the Terry Skeletal Collection. General health markers including periostitic and osteolytic activity was recorded for each individual. Only 15 of the 125 cases (12%) exhibited lesion activity. Among those with lesions, only 13 were diagnosed specifically with pulmonary tuberculosis, and within that set, 5 skeletons lacked inflammatory rib lesions (38.46%). Interestingly, 3 of those 5 presented with advanced thoracic vertebrae lesions but no rib lesions. Indeed, one individual had extensive lytic lesions in the scapula, sacrum, and vertebrae, none of which are classical tuberculosis indicators. Therefore, this research suggests that the diagnostic criteria for pulmonary tuberculosis should include an assessment of both periostitic and osteolytic activity.

**Cranial shape and the transition to agriculture**

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The Neolithic brought about fundamental changes in mobility, mating patterns, diet and lifestyle in human populations. Some of these social, dietary and behavioural changes impacted the skeletal morphology of these populations. Cranial morphology is shaped by the combined action of genetic, ontogenetic and environmental factors, reflecting various elements of the individual's life. To determine the transition's effect on cranial morphology, we investigated its impact on the face and the cranial vault, two elements that may respond to different influences.

Three data sets from geographically distant regions (Ukraine, Iberia and Near East) were analysed. Craniometric measurements were used to characterise the morphological variation, comparing the variation observed in pre-transition hunter-gatherer populations to that of agricultural populations. The transition corresponds to a relative increase in maximum cranial breadth, most notably in the mid-parietal region in all three geographical regions. However, facial morphology does not appear to change in any consistent manner, despite expected changes associated with changing masticatory behaviour.



The relative broadening of the cranial vault has previously been attributed to causal factors such as climate or geography. However, three independent occurrences of this phenomenon associated with the Neolithic transition suggest otherwise. Comparison of pre- and post-transition morphospaces indicates that skull morphologies observed in pre-transition populations are not lost across the transition, but rather the range of observed variation is increased, pointing to a relaxation of morphological constraints on cranial dimensions following the transition to agricultural practice.

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**Partial skeleton of early Eocene *Tinimomys graybulliensis* (Primates, Micromomyidae) from the Clarks Fork Basin, Wyoming**

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Micromomyidae includes eleven species of small plesiadapiforms known from the late Paleocene to the early Eocene of western North America. Comprehensive phylogenetic analyses support micromomyids as the most basal stem primates other than the oldest known plesiadapiform, *Purgatorius*. These results and recent observations that *Purgatorius* astragali and calcanei are uniquely similar to those of micromomyids suggest that fossil skeletons of micromomyids currently represent the best evidence for understanding postcranial skeletal morphology of the ancestral primate. Previous preparation of a freshwater limestone nodule from the early Eocene of the Willwood Formation, Clarks Fork Basin, Wyoming, produced a dentally-associated partial skeleton of the micromomyid *Tinimomys graybulliensis* (USNM 461201) that included a partial vertebral column, ribs, and several forelimb elements. No hind limb elements were thought to be preserved during initial preparation, a relatively long intermediate phalanx was attributed to the manus, and it was suggested that micromomyids had a dermopteran-like gliding membrane with interdigital patagia. Recent preparation of this same limestone nodule yielded many hind limb and additional elements clearly associated with USNM 461201, making this specimen one of the most complete plesiadapiform skeletons known. Comparisons of phalanges of *T. graybulliensis*, the micromomyid *Dryomomys szalayii*, and other euarchontan mammals demonstrate that these micromomyids did not have elongate intermediate manual phalanges like those of

dermopterans. The postcranial morphology of *Tinimomys* is very similar to that of the arboreal and most basally divergent treeshrew, *Ptilocercus lowii*, suggesting that the most primitive primates were claw-climbing arborealists that used orthograde postures on vertical supports.

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**Status and Activity in Prehistoric Central California: Patterns of Osteoarthritis in a Social Context**

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Social identity addresses key parameters of behavior in the context of wealth and status, both in past and living contexts. Material goods left behind at death and evidence of an individual's activity level may reflect the social roles they held throughout their lives. This study tests the hypothesis that relative wealth and social role as displayed in material associations is generally correlated with labor and activity. To test this hypothesis, osteoarthritis is documented as an indicator of activity in four prehistoric archaeological sites from the Sacramento-San Joaquin Delta region (4800-250 BP, n = 120). Patterns of osteoarthritis are compared to the presence and quantity of charmstones and quartz crystals as ritualistic artifacts, shell beads and ornaments as indicators of wealth, and projectile points and bone tools as technical items.

Individuals without artifacts exhibit a higher prevalence of osteoarthritis than the individuals who were buried with artifacts ( $\chi^2 = 37.0$ ,  $p < 0.05$ ). These individuals may have been more active and undertook more strenuous labor than the individuals with at least one artifact. Individuals without shell beads exhibited a significantly higher prevalence of osteoarthritis in the lower limb than individuals who were buried with shell beads ( $\chi^2 = 3.931$ ;  $p = 0.040$ ), and individuals buried without charmstones had a significantly higher prevalence of osteoarthritis in the upper limb than those buried with charmstones ( $\chi^2 = 9.55$ ;  $p = 0.010$ ). These findings suggest an association between social role and activity in this region.

**Neck-Shaft Angle and Climate-Induced Body Proportions**

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There is considerable temporal and geographic variation in femoral neck-shaft angle (NSA). Traditionally, a lower NSA is linked to an increased level of physical activity during life. More recently, however, research suggests that lower NSA might also be explained, in part, as the mechanical consequence of differences in ecogeographic body proportions. This study tests the proposed link between climatic-induced body proportions and NSA through the course of development in a sample of geographically diverse children. Data suggest that starting at a very early age, there is a significant interaction between NSA and body mass and shape, and that this relationship differs among children with different body proportions. These results, combined with other studies, suggest a mechanical interaction between proximal hip geometry and the changing angle of hip joint reaction forces during development. The functional significance of this, both in terms of evolutionary change and developmental plasticity, is that variation in body proportions alter the angulation of applied loads across the proximal metaphysis in the developing femur, thereby resulting in differing adult NSA. This study highlights the importance of the angulation and distribution of mechanical loading in the skeletal adaptation of the femur.

**Genetic variation in central obesity measures and serum uric acid in American Indians**

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We sought to determine whether single nucleotide polymorphisms (SNPs) associated with serum uric acid (SUA) in 1108 American Indian participants in the Strong Heart Family Study (SHFS, n = 3604) are also associated with central obesity in this population. We have shown significant genetic influence on variation of SUA in the SHFS, then identified associations with SNPs in genes related to uric acid transport (*SLC22A11*, *SLC17A1*, *SLC16A9*), breast and endometrial cancer (*BCAS3*, *UBE2Q2*, *INHBC*), and diabetes (*GCKR*) at  $p < 8 \times 10^{-4}$  after accounting for multiple testing. Epidemiological studies have shown that SUA is associated with central obesity measures such as body fat, waist circumference, and waist-to-hip ratio. We used a measured genotype analysis in SOLAR, accounting for family relationships, to explore the genetic underpinnings of the significant

## AAPA Abstracts

phenotypic correlations we observed between waist circumference or body fat with SUA. SUA-associated SNPs were significantly associated with body fat, waist circumference, and waist-to-hip ratio; the top six SNPs were rs2079742 (A): *BCAS3*, rs2078267 (A): *SLC22A11*, rs17300741 (G): *SLC22A11*, rs1394125 (A): *UBE2Q2*, rs3751043 (G): *USP3*, and rs2242206 (C): *SLC16A9* (MAF between 10 and 39%; all  $p \leq 8 \times 10^{-4}$ ). In summary, the association of SUA markers with central obesity suggests possible pleiotropic genetic effects determining adiposity, SUA and related metabolic risk in American Indians providing insight beyond that from epidemiologic studies of SUA and adverse cardiometabolic outcomes.

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#### Effects of male social upheaval on social bonds and stress in female chacma baboons

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Female baboons form long-lasting bonds with other females (that reduce stress and increase fitness) as well as shorter-term ties with males (presumably to reduce harassment and infanticide). These bonds can be dynamic and may change in response to threat of infanticide from immigrating males and loss of preferred social partners, both of which may increase physiological stress levels. Here we examine the impact of social instability on female social bonds and stress in chacma baboons (*Papio hamadryas ursinus*) in the Cape Peninsula of South Africa, where the number of adult males in a troop with 6-7 adult females fluctuated from 3 to 6 between Dec 2009 and Sep 2011. Following a period of relative stability of male membership, 9 different males immigrated or attempted to immigrate following the death of the longest residing male. Here we explore female responses to this male turnover. We examine variation in patterns of social bonding with both females and males in light of female characteristics such as age, parity, rank and especially reproductive state (as females with infants may have more to lose from infanticidal male immigrants, whereas cycling females may benefit from novel mating partners). During social instability, females associated more with other females and less with resident males, while infant mortality rose from 0 during male stability to 40% during social instability. These results support the idea that the behavioral and physiological flexibility of female baboons is an important mechanism of coping with and adapting to changing social stressors.

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#### Geometric methods of body mass estimation in small-bodied hominins

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Body mass is an ecologically- and biomechanically-important variable in the study of early hominin biology. Regressions derived from recent human samples allow for the reasonable estimation of body mass of later hominins (genus *Homo*) from hip joint dimensions, but potential differences in hip abductor biomechanics across hominin taxa render questionable their use with early hominins (such as *Australopithecus*). Geometric methods of mass estimation using stature and bi-iliac breadth avoid this problem, but their applicability to early hominins that differed in body size and proportions from adult recent humans has not been demonstrated.

Here we use mean stature, bi-iliac breadth, and body mass from global samples of human children ranging in age from 6-12 years (N = 530 age- and sex-specific samples, from the literature) to evaluate the accuracy of these methods when applied to small-bodied samples (who also differ in proportions from adult human reference samples). Geometric methods systematically underestimated mass in the younger (6-9 year old) age groups (median prediction errors ranging from -0.2 to -5 kg, representing median errors of 1.0-32.7%), who are smaller on average (grand mean body masses of 19.7-26.3 kg) than most australopiths (ca. 29-45 kg). These methods moderately overestimated mass in the older (10-12 year old) groups (by 1.2 to 3.2 kg [3.9-7.9%]), whose body masses (grand means of 29.2-36.2 kg) fall in the range of adult *Australopithecus*. While further testing with additional samples is warranted, these results suggest that stature and bi-iliac breadth may reasonably be used to estimate mass in small-bodied hominins.

#### Let's talk about race, maybe: Teaching about identity as a tool to engage future scientists

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Anthropologists and social scientists can have a positive effect on the education of high school students—engaging them with social science methodologies to examine the meaning of race and its place in science—in a way that creates an inclusive scientific environment. Social science

approaches to race and identity, including ethnographies, participant observations, and survey design, create opportunities for students to engage with their racial, ethnic, and gender identities. This process of cultivating knowledge and awareness about diversity is consistent with a cultural competence approach; research suggests this helps individuals understand experiences different from their own, and the broader context in which historical, social, and cultural factors influence the practice of science. In a summer science camp for high school girls, we sought to expose students (n = 60) to discussions of race and identity. Using a grounded theory, participant-observation approach, we implemented our teaching materials over two summers from one that used body image and ancestry as the entry point through which to discuss race, to one that subsequently introduced the ecological systems approach and racial health disparities. We found that the students in our sample were unprepared to discuss race, as they had largely learned these discussions were dangerous. Modifications in our second year created more opportunities for students to speak from personal experience and engage with topics on race. Implications for best practices in teaching anthropology at K-12 and higher ed levels will be discussed. Suggestions will also be provided for collaborating across social science disciplines.

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#### Lateral enamel formation of anterior teeth and life history in New World monkeys

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Aspects of dental development such as first molar eruption, crown formation time, and occlusal enamel formation rates are associated with life history variation in primate posterior dentition. However, relationships between enamel formation in anterior teeth and life history in living species have not been previously examined, even though several studies of fossil hominins have focused on anterior teeth. This study explores the relationship between life history variation and estimated lateral enamel formation time, as well as percent of perikymata in the cervical half of the crown in the incisors of twelve extant species of platyrrhines. Platyrrhines were chosen due to their high life history diversity. The sample analyzed consists of ten teeth from each of the four incisor tooth types for all twelve species. Only incisors with mammelons or with very minimal wear were included. Perikymata were counted using a measuring microscope and periodicities were taken from the literature. Measures of life history and related variables include: encephalization

quotient, age at weaning, age at reproductive maturation, average lifespan, brain size, and body size. Results of phylogenetically corrected simple linear regressions show that estimated lateral enamel formation time is significantly correlated with all variables and percent of perikymata in the cervical half is significantly correlated with encephalization quotient, brain size, and lifespan. These results suggest that estimated lateral enamel formation time in incisors reflects important aspects of life history in platyrrhines and may be useful in the prediction of life history profiles of fossil platyrrhines.

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#### **Dental Health in a Late Prehistoric Population from Northeastern Ohio**

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Teeth are of particular importance in bioarchaeology because they are largely resistant to the processes of natural decomposition. Specifically, linear enamel hypoplasias (LEH) have traditionally been used to examine stress in archaeological populations. LEH are areas of thinner enamel deposits resembling grooves or furrows that are thought to result from episodes of physiological stress such as nutrient deprivation and disease during early childhood development. Similar to LEH, caries are one of the most frequently recorded skeletal pathologies in bioarchaeology. The purpose of this project was to evaluate the dental health among Indigenous American adults (n=37) excavated from the Norma Grantham site in Lake County, Ohio. Systemic physiological stress episodes were noted by counting the number of LEH in similar positions in antimeric pairs. Caries were counted by examining the teeth under a light microscope at 1.6 times magnification.

Results show that the average number of caries exhibited by females (n=18) in this sample was 14.61. The average number of caries for males (n=17) was 15.29. There were two individuals for whom sex could not be estimated. Both of these individuals exhibited 20 caries. Finally, there were 13 individuals (35.14%) who exhibited antimeric LEH. Of those, seven were male, and six were female. The two individuals of unknown sex did not exhibit any LEH.

These results are consistent with the widespread physiological stress and subsequent decline in dental health following the transition from hunter-gatherer subsistence strategies to those of agriculture.

#### **Morphological signals of stress and socioendocrinology: Comparing measures of cranial fluctuating asymmetry and second to fourth digit ratio in cercopithecids**

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Fluctuating asymmetry (FA) has been hypothesized as a signal of phenotypic quality. Because males have been shown to have more asymmetries, FA has been hypothesized to relate to both testosterone levels and mating strategies. Additionally, second to fourth digit ratio (2D:4D) has been correlated with developmental androgen testosterone levels. In this analysis we compare data on 2D:4D and cranial FA of cercopithecidae to examine the correlation between morphological signals of stress and socioendocrinology.

Forty-five landmarks were digitized using a Microscribe-3DX© for 160 male and 123 female crania, representing 10 cercopithecoid species, classified according to mating system and degree of male-male competition. Statistical analyses were done using SAS. FA was measured by calculating the Procrustes' distance between each individual and its mirror-image. Sex specific 2D:4D were taken from the literature. A two-way ANOVA with *a priori* multiple comparisons between mating systems was used to examine variation in individual FA using sex and species as main factors. The relationship between FA and 2D:4D averages were compared with parametric correlation.

Cranial FA shows a slight positive relationship with centroid size (P=0.023). Species differ in cranial FA (F=3.35, P<0.001), but there was no difference between sexes (F=2.93, ns) and no sex-species interaction (F=1.73, ns). Cranial FA shows no difference among mating systems (F=0.00, ns), or with the 2D:4D within sexes among species (r=0.16, ns). Our results suggest that 2D:4D is not highly correlated with cranial FA and that although testosterone may relate to 2D:4D and FA, the relationship is complicated by male-male competition, sexual dimorphism, and phylogeny.

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#### **Differences in Diet between and Within Medieval Fishergate House, York, and Wharram Percy, Yorkshire: As Told by Dental Calculus and Scanning Electron Microscopy**

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Palaeodietary reconstruction is an important component in the overall understanding of past humans populations. Dietary variation between and within populations is often the result of differences in subsistence strategy, age, sex/gender, social status and temporal and spatial location. This research used an innovative approach in the analysis of dental calculus, combining it with scanning electron microscopy in order to analyse phytolith microfossils to determine if dietary differences were present between the medieval (AD10<sup>th</sup>-AD16<sup>th</sup> century) populations of Fishergate House, York, and Wharram Percy, Yorkshire. Specifically, this research sought to answer whether these populations' diets varied as a result of their urban and rural locations, and whether sex-based dietary differences were present. It was predicted that there would be a difference in phytolith presence between the populations, with Wharram Percy having greater phytolith presence, due to rural communities being more restricted in dietary variety, and that females would have greater phytolith presence than males due to the medieval practice of sexual stratification of food. Results found that there were no statistically significant differences in phytolith presence between or within the populations. The lack of difference in diet could be a result of: immigration from Wharram Percy into Fishergate House; a difference in calculus presence and severity between the populations; differences in diet and standards of living preceding the Black Death; the limitations of this methodology to only provide dietary information on plant consumption; and, probably the most likely influence, that dietary influences may be superseded by social status.

#### **A preliminary look into the ontogeny of femoral neck cortical bone distribution using $\mu$ -CT**

ALEXANDER CLAXTON. Department of Anthropology, Boston University.

The thickness and distribution of cortical bone in the femoral neck has been used to infer bipedalism in the hominin fossil record. Previous studies have only examined the expression of this trait in adult individuals, but an ontogenetic approach would give great insight into its nature – specifically to what extent it is a remodeling response or a Darwinian adaptation. The proximal femora of chimpanzees and humans from various ontogenetic stages were  $\mu$ -CT scanned and segmented. The ratio between the superior/inferior cortical thicknesses at the base of the femoral neck in an adult chimpanzee ranges between 0.9-1.5, but the juvenile and adolescent individuals scanned here have ratios of 0.16 and 0.33, respectively – meaning that these subadults are about as asymmetric as adult modern humans. These data show that the ratio of cortical bone changes ontogenetically in chimpanzees. It is unlikely, however, that Wolffian remodeling is wholly responsible for thick superior cortex in apes, as the locomotor



## AAPA Abstracts

repertoire in late adolescent chimpanzees is similar enough to an adults for there to be an equivalent amount of strain. Adult humans have a sup/inf ratio of ranging from 0.2-0.5, and the subadult individuals scanned here had ratios of 0.21 and 0.26, respectively. A roughly adult internal morphology appears to be present in humans by at least late childhood, judging by the skeletal ages of the specimens. Chimpanzees and humans appear to differ with respect to the onset of adult anatomy in this particular trait.

**Reading the sources: How the historical record can help interpret results**

MARGARET CLEGG. Department of Earth Sciences, Natural History Museum.

When we interpret archaeological sites it is sometimes forgotten that there is a whole body of research based on writing from the historic era. This information can help in the interpretation of analysis of the human remains found at these sites. The Romano-British site at Poundbury in Dorset has a large number of children buried within it. These children show signs of deficiency diseases such as rickets. Two competing explanations have been proposed for this high level of disease the first that the children are low status; despite the adult burials being high status, the second that the effects of urbanisation and dietary change are responsible for the effects shown. A literature review of the adoption of the roman life style in Britain including child rearing practices, which pre-dates the Roman invasion in the South West of England shows that a more Romanised diet was eaten supports the view that lifeway changes are responsible the prevalence of deficiency diseases. This is particularly true of children as changes in the use of dairy products in a climate with a low level of sunshine would produce vitamin deficiencies. This shows the importance of understanding the context and background of such sites and applying known information to results.

**Engaging students through active participation in a community-based conservation initiative**

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The Tonkolili Chimpanzee Project (TCP), a recently developed field site in central Sierra Leone, offers students experiential learning opportunities through participation in community-based conservation initiatives. At the TCP, students play an integral role in the management and operation of the site, which allows them to experience the successes and challenges that oftentimes accompany community-based conservation projects. In two field seasons thus far (2013-2014), students have

had the opportunity to discuss and assist in the development of solutions to problems such as: unauthorized logging in chimpanzee habitat, the retaliatory hosting of a hunter by an outlying village, and cultural conflicts with local communities. Students have also had the opportunity to participate in the collection of chimpanzee population census and camera trap data, as well as informal interviews, community workshops and seed dispersal analyses. By allowing students to witness and participate in the real world problem-solving aspects of a fledgling conservation site, students garner experiences that they can build on in their academic careers.

**Analysis of dental pathologies from the Late Woodland osteological sample from Schroeder Mounds**

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Schroeder Mounds (11He177) is a later Late Woodland (900-1100 AD) mortuary context from west-central Illinois. No village site is associated with the mounds. The adult sample (total N=56) was examined for the prevalence and pattern of a suite of dental pathologies (i.e., alveolar bone loss, abscesses, antemortem tooth loss, and calculus) in an effort to provide some insight into the diet or subsistence economy. The pathologies were scored (presence/absence, severity) and assessed by age (young, middle aged, and older adult) and sex to test for health patterns. Not surprising, older adults have the most antemortem tooth loss ( $p < 0.01$ ). The number of teeth affected and severity of calculus were differentially affected by tooth. Only right 1st incisors and lower left 2<sup>nd</sup> molars had significantly more calculus than all other teeth. There were several dental pathologies that exhibited patterned sex differences. Over 50 percent of females had antemortem tooth loss, compared to only 28 percent of males. For various reasons, males apparently experience more periodontal disease ( $p = 0.042$ ). Sampling error should always be considered a possible explanation, but it is also possible that there were sex-based differences in consumption or mastication which negatively impacted male oral health.

**Chimpanzee brain size growth: Comparing captive mass and wild volume data**

ZACHARY COFRAN. School of Humanities and Social Sciences, Nazarbayev University.

This study compares postnatal brain size change in two important chimpanzee samples: brain masses of captive apes at the Yerkes National Primate Research Center, and endocranial volumes (ECVs) of wild-collected individuals from the Tai Forest. Importantly, age at death is

known for every individual, so these cross-sectional samples allow inferences of patterns and rates of brain growth in these populations. Previous studies have revealed differences in growth and health between wild and captive animals, but such habitat effects have yet to be investigated for brain growth. It has also been hypothesized that brain mass and endocranial volume follow different growth curves. To address these issues, I compare the Yerkes brain mass data ( $n=70$ ) with the Tai ECVs ( $n=30$ ), modeling both size and velocity change over time with polynomial regression. Yerkes masses overlap with Tai volumes at all ages, though values for the former tend to be slightly elevated over the latter. Velocity curves indicate that growth decelerates more rapidly for mass than ECV. Both velocity curves come to encompass zero between three and four years of age, with Yerkes mass slightly preceding Tai ECV. Thus, Yerkes brain masses and Tai ECVs show a very similar pattern of size change, but there are minor differences indicating at least a small effect of differences in habitat, unit of measurement, or a combination of both. The overall similarity between datasets, however, points to the canalization of brain growth in *Pan troglodytes*.

**Trabecular structure of the mandibular condyle and food mechanical properties in non-human primates**

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Attempts to demonstrate the widely hypothesized relationship between food mechanical properties (FMPs) and jaw morphology have proven inconclusive. The temporomandibular joint is loaded during mastication, and the trabecular structure of the mandibular condyle may reflect differences in dietary FMPs in non-human primates. The relationship between FMPs and measures of trabecular architecture was tested using a sample ( $N = 8$ ) of extant primate mandibles. Each mandible was scanned using high-resolution X-ray computed tomography (HRXCT). A 30-pixel cubic volume of interest from the center of the mandibular condyle was selected using ImageJ and analyzed with Quant3D. Bone volume fraction (BV/TV) and degree of anisotropy (DA) were calculated for each volume of interest. Values for maximum, median, and weighted mean toughness ( $R$ ) of foods eaten by each species were taken from the literature.

Results of regressions of BV/TV and DA against toughness yielded no significant results, although the available sample is small. For BV/TV, median toughness most closely approached significance ( $R^2 = 0.16$ ,  $p = 0.18$ ). Maximum toughness, which may represent the selective pressures associated with fallback foods, had no effect ( $R^2 = -0.11$ ,  $p = 0.6$ ). Previous work



suggested that BV/TV has a significant relationship with average daily time spent feeding. Thus, the lack of a relationship between BV/TV and FMPs suggests that repetitive loading of the jaw through mastication may be a more important driver of trabecular structure in the mandibular condyle.

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#### **A semi-automatic method for intracortical porosity quantification with application to intraskeletal variability**

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Bone mass varies during life in response to environmental factors such as health, diet, and mechanical strain. Within archaeological populations, temporal trends in bone mass have been linked to changes in mobility, physical activity, and diet. Anthropologists often approximate bone mass as relative cortical area (RCA), or the percentage of cortical bone within a cross-section. RCA measures cortical bone as a solid mass, but this bone is perforated with numerous vascular and resorption spaces. Due to this porosity, RCA significantly overestimates bone mass and may distort inferences about environmental factors. Manual correction for porosity takes time and thereby limits sample size, while automatic correction requires microradiograph images. This study presents a more accessible semi-automated protocol for porosity quantification using brightfield microscopy. The values of porosity produced by the semi-automatic method and the manual method did not vary significantly in a sample of eleven human ribs ( $p = 0.532$ ). Correction for cortical porosity alone and for total porosity significantly reduced RCA in femora, tibiae, and ribs of nine individuals. This protocol also automatically differentiates between cortical pores and “trabecularized” or coalesced resorption bays at the endosteal border. Within single individuals, the rib displayed significantly greater trabecularized porosity than the femur ( $p < 0.0009$ ) or tibia ( $p = 0.004$ ). Trabecularization was localized to the tensed cutaneous cortex of the rib ( $p = 0.011$ ), rather than its compressed pleural cortex. Lower levels of mechanical strain near the endosteum and in tensed cortices produce this high porosity.

#### **Reaching beyond Anthropological Genetics: Michael Crawford's Contribution to Genetic Epidemiology**

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To those familiar with the field of anthropological genetics the contributions of Dr. Michael Crawford are well known. Dr. Crawford played a critical role in the coalescence of Anthropological Genetics into a recognized field of study with the publication of the seminal work on the topic, “*Methods and Theories of Anthropological Genetics*” (Crawford and Workman, 1973), which arose from a workshop that he organized in the early 1970's. Perhaps a bit less well appreciated, however, has been his impact on the field of genetic epidemiology. Through both his active research career as well as his role as teacher and mentor, he influenced a generation of students who have taken the perspective and approaches of anthropological genetics and have applied them in the context of genetic epidemiology to address critical issues in biomedical research. In this presentation we will summarize some of our key findings from a wide-range of ethnic populations (e.g., Alaskan Natives, Native Americans, Mexican Americans, and Arab Bedouins), as well as nonhuman primates, where we have identified important genetic factors influencing metabolic conditions with significant public health implications for an individual's risk for the development of obesity, diabetes, and cardiovascular disease. All of these studies have at their core the utilization of large extended family structures, often utilizing cultural characteristics and environmental factors unique to these populations. Additionally we will highlight how we are utilizing these findings in a translational perspective with current work in gene therapy utilizing a baboon model of type 1 diabetes.

#### **Hands Up: Pedal Digit Use during Arboreal Quadrupedalism and Bipedalism in *Propithecus coquereli***

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It has been hypothesized that the precursor of terrestrial bipedalism occurred in an arboreal primate that engaged in upright postures during vertical climbing and arboreal bipedalism. Sifakas (*Propithecus coquereli*) are arboreal primates specialized for vertical clinging and leaping. This specialization includes exceptionally long legs characteristic of bipeds that for this species aid in pushing off from vertical substrates during explosive leaping. Elongate hindlimbs make quadrupedal terrestrial locomotion awkward, and sifakas are known to travel via bipedal hopping when on the ground. However, when moving on horizontal arboreal substrates, *Propithecus coquereli* uses both quadrupedal and bipedal locomotion. Understanding differences in foot use between these two behaviors in *Propithecus* could help

identify the selective pressures on the foot of the hypothetical ‘pre-bipedal’ arboreal primate. This study hypothesizes that bipedal arboreality requires higher digital pressures as compared to quadrupedal arboreality, perhaps to enhance stability. A comparison of digital grasping pressures in a sample of 2 adult *Propithecus coquereli* housed at the Duke Lemur Center demonstrated that overall pedal pressures were higher during bipedal arboreality than quadrupedal arboreality, as were pressures exerted by individual digits, with the most lateral digits more frequently employed during bipedal arboreality. Following evidence that phalangeal curvature is functionally related to arboreal grasping, these findings suggest that primates engaging in arboreal bipedalism would exhibit increased pedal phalangeal curvature versus those that employ arboreal quadrupedalism. A combination of increased pedal phalangeal curvature, low intermembral index and upright trunk posture could help identify the ancestor of terrestrial bipedality in the human lineage.

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#### **Trabecular bone at the knee reflects changes in load orientation during ontogeny**

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The femoral bicondylar angle develops during ontogeny in response to changes in loading associated with the onset and maturation of bipedal walking. The magnitude and orientation of loads at the knee joint change significantly during development as the bicondylar angle increases and then stabilizes. The goal of this study is to assess trabecular bone structural changes in the distal femur in relation to the developing bicondylar angle with the expectation that bone structure will reflect a shift in load magnitude and orientation at the knee during ontogeny. Three-dimensional trabecular bone architecture in the distal femur was quantified from microCT data in 57 individuals from the Norris Farms #36 archaeological skeletal collection. Bicondylar angle was quantified by measuring the angle between the long axis of the bone and the distal femoral metaphyseal margin. Individuals ranged in age from neonate to adult. We found no significant differences in bone volume fraction (BV/TV), trabecular spacing, or connectivity between the medial and lateral metaphyses in any age group. Trabecular bone in the medial metaphysis was significantly thicker

and more isotropic than in the lateral side across all age groups. The degree of anisotropy (DA) in the medial condyle was the only variable significantly correlated with bicondylar angle. These results suggest that trabecular bone structure in the distal femoral metaphysis does not reflect changes in load magnitude (BV/TV), but appears to track changes in load orientation (DA) in the medial condyle during skeletal development, and the acquisition and maturation of bipedal gait.

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**Walking back the cat: Unsupervised classification as an aid in “remote” fossil prospecting**

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Counterintelligence agents use a technique, “walking back the cat,” to ferret out “moles.” They compare what is now known as fact against what the “moles” had told them to expect. It is a metaphor for “working backwards,” retracing the complex development of events to gain useful insights about how those events unfolded.

“Remote” prospecting in paleoanthropology may profit from such an approach. In supervised classification, one has to have *a priori* knowledge of various land cover classes in the satellite coverage area. Spectral signatures are then derived through pixel training algorithms for the image classification to proceed. But what if we *don't* have *a priori* knowledge of these land cover classes and are unable to train pixels to identify specific land cover classes, including possible fossiliferous outcrops? Unsupervised classification enables one to retrace our steps, “walk back the cat,” to identify other potential fossiliferous outcrops even when one hasn't been able to specifically train pixels to find them.

The potential power of this technique is illustrated by an example from Eocene beds of the Uinta Basin, Utah, an area encompassing some 665 square miles. I show that if one knows the location of only one or two fossiliferous localities within this vast geospatial landscape, unsupervised classification methods give paleoanthropologists the chance, at least, to “walk back the cat” in order to deduce the location of promising areas for future fossil prospecting *even in the absence of any a priori knowledge of landscape cover over the proposed survey area.*

**Virtually there: Using live-feeding cameras to teach primate behavior**

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A number of zoos now have cameras that allow people to observe a variety of primate species in real time. This technology has the potential to transform how instructors teach the methodologies behind the study of primate behavior. It offers an inexpensive and dynamic way to introduce concepts such as ethograms, instantaneous and continuous focal sampling, activity budgets, and inter-observer reliability. We developed an in-class activity for introductory and advanced biological anthropology students using live-feeds of primate behavior. Some of the live-feeds we used include: Blank Park Zoo Snow Monkey Cam, Callicam, National Zoo Orangutan Cam, San Diego Zoo Ape Cam, and Zoo Atlanta Tamarin Cam. We present qualitative results on the effectiveness of live-feed activities that were collected from ten classes (nine introductory biological anthropology and one upper-level primate behavior) over five semesters at both the community college and university level. The use of live-feeds presented both positives and negatives in students' experiences and their comprehension of ethological methods. For example, the San Diego Zoo Ape Cam was the most reliable in terms of the quality of the exhibit and the camera feed, but the animals were frequently out of view. We also experienced technical difficulties with some of the live-feeds. Overall, live-feeds are a beneficial tool for student learning but one that should be approached with caution and preparation. Therefore, we also present some suggestions for the successful use of live-feed cameras in the classroom.

**The single life: Physical injuries may reflect the costs of being a solitary owl monkey**

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Azara's owl monkeys (*Aotus azarae*) are socially and genetically monogamous, territorial primates in which offspring of both sexes disperse from their natal groups. After dispersing, individuals range solitarily for a period ranging from a few days to many months. Understanding the behavior and physiology of individuals during the solitary life history stage is relevant for illuminating the evolution and maintenance of serial monogamy observed in this species. While dispersing earlier may allow individuals to maximize their reproductive life spans if they establish themselves as reproductive adults sooner, it may also carry costs. We predict that solitary subadults will be smaller, lighter, show

fewer signs of adult development (e.g. gland secretions), and more frequently have scars, torn ears, and other signs of injuries indicative of intraspecific fighting than similarly aged, predispersing, subadults. As part of the Owl Monkey Project in Formosa, Argentina, we collected morphometric data from 62 subadults (aged 24-48 months) captured between 1999 and 2014. Differences in weight, body length, or gland development between solitaries and subadults in social groups did not reach statistical significance. However, a greater proportion of solitaries showed signs of injuries than predispersing subadults (69% versus 23%, Fisher's Exact Test: odds ratio=0.133, CI=0.02-0.59). While our results do not support the idea that dispersing early carries costs in terms of growth or development, solitaries do seem to face higher rates of injuries. Ongoing studies characterizing hormonal levels of solitaries and examining encounters between solitaries and social groups will further elucidate the potential costs of early dispersal.

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**Disability, care, and identity in the Middle Woodland period: Life at the juncture of achondroplasia, pregnancy, and treponematosi**

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A rare case of pre-Columbian achondroplasia provides a vehicle for exploring aspects of care-giving, as well as broader social and individual implications of disability during the Middle Woodland Period in the Lower Illinois Valley. To interpret care-giving within this cultural context, an adult individual (EZ 3-7sk1) and fetal individual (EZ 3-7sk2) from Burial 7 of Mound 3 of the Elizabeth site in Pike County, Illinois were evaluated using Tilley's “Index of Care.” This bioarchaeological methodology provides a practical framework for addressing issues of disability and care within the archaeological record.

This poster presents the pathological and osteological evaluations of the two individuals, the resulting differential diagnoses, and the estimation of disability requiring care. The skeletal manifestations of skeletal dysplasia, minimal arm mobility, and extreme manifestation of tertiary treponematosi throughout the skeleton could have resulted in pain and limited movement. These movement deficiencies would have been exacerbated by a nearly full term pregnancy. The consideration of the achondroplasia, treponematosi, pregnancy, and restricted mobility in conjunction suggests that the individual had a disability that required

care or "direct support" in order to survive and successfully function within the society. This application and analysis will allow for an exploration of the relation between health challenges, support, and social behaviors in the Middle Woodland period of the Lower Illinois Valley. The use of this approach will contribute to the broader theoretical debate on the origins of care-giving and its visibility in the archaeological record.

**Phylogenetic relationships of Night Monkeys (*Aotus*): Evidence from pelage coloration and molecular data**

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Night monkeys (*Aotus*) are the only nocturnal anthropoids and the second most geographically widespread genus of platyrrhine. In the revision of the genus conducted by Hershkovitz (1983), 11 taxa were recognized and divided in two groups, the gray-neck group north of the Amazon River and the red-neck group south of the Amazon River. Following this scheme, there are currently 13 recognized taxa (Mittermeier et al. 2013). The relationships within the genus are poorly understood as there is no phylogeny using morphology. Moreover, molecular phylogenies have suggested that the neck-coloration grouping may be paraphyletic (e.g. Menezes et al. 2010), although no more than eight taxa have been included in these analyses. We tested the current grouping scheme and assessed the phylogenetic relationships within this genus using pelage coloration traits collected from museum skins and sequence data from the mtDNA COI, COII and CYTB regions for 12 taxa. Bayesian and maximum parsimony analyses were conducted with the pelage and molecular datasets individually and in a combined matrix analysis. Two major clades were recovered consistently through all the analyses with very high support (*A. nancymae*, *A. miconax*, *A. vociferans* and *A. brumbacki*; and, *A. azarae infulatus*, *A. azarae boliviensis*, *A. azarae* and *A. nigriceps*), which seems to be associated with biogeographic regions, such as central-northern Andes and central-southern Amazonia. The neck coloration grouping scheme dissolves under all these analyses, supporting the findings from previous works and questions the taxonomic usefulness of this trait.

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**Biological Distance of the Effigy Mound Phenomenon in Southern Wisconsin: A Complementary Approach to Understanding Social Organization**

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The purpose of this presentation is to report on the results of a biological distance analysis of eight Effigy Mound groups and how these results complement and inform a contextual bioarchaeological analysis on the corporate identity of the Late Woodland Effigy Mound phenomenon of southern Wisconsin.

In a previous study it was demonstrated that the position and disposition of burials in mounds is variable among Effigy Mound groups (Cornelison et al. 2012). This variability has been associated with the demarcation of corporate identity among mound groups. This was likely attributed to ritual leaders asserting corporate identity through purposeful planning, improvisation of rituals not frequently performed, and/or by asserting their authority by creatively emblemizing their group's identity.

The results of this study, employing Smith's Mean Measure of Divergence (MMD), demonstrate patterns similar to those found in the previous contextual analysis. Three important patterns emerge from this analysis. First, it is demonstrated that there is an association between biological and geographic distance. Second, intra- and inter-regional contextual patterns show similar results to the MMD among mound groups. Finally, one of the mound groups that exhibited demonstrable differences among all the mound groups is found to be phenetically distant from most other mound groups.

Although there was an overarching Effigy Mound social organization, the results of this study demonstrate that corporate lineal groups were maintaining specific mound groups. Furthermore, the function of certain mound groups may have focused more on ceremonialism rather than as bounded cemeteries.

*I would like to express my appreciation for funding of this project by the MSU Graduate School Kenneth E. Corey Research Enhancement Award.*

**Drawing the Line: An Exploration into the Complex and Contradictory Relationships between Humans and Other Primates**

AMANDA D. CORTEZ. Department of Anthropology, University of Notre Dame.

In the United States, the practice of keeping animals in captivity has become a norm that is justified by the advancement of humanity. Our culture holds a position of dominance over the other primates, which often results in constructing them as the "Other," allowing humans to use them as we see necessary. Expanding upon the current research in ethnoprimateology, which examines the human-other primate interface, this research explores the ways in which humans relate to and perceive other primates in the captive settings of a biomedical research facility, a zoo, and an animal sanctuary. I used the ethnographic methods of semi-structured interviews, observation, participant observation, and discourse analysis. Over eleven months, I interviewed two lab workers, two zoo-keepers, and three caretakers, observed zoo-visitors interact with zoo animals, and participated as a lab worker and sanctuary volunteer. I then transcribed and coded my fieldnotes and interviews for data analysis. My findings show that the discursive practice of human exceptionalism has facilitated human treatment of other primates so that their captivity is justified on the basis of advancing humanity. I demonstrate that in each site, humans exercise 'biopower'—a Foucauldian concept used to understand how a dominant group maintains total control over subalterns—over the other primates, who are deemed 'bare life,' a notion of valueless existence. This study will help us to understand our hierarchical relationships with other primates, how they allow for exploitation, entertainment, or conservation values, and what this teaches us about the construction of "human nature."

**The effect of bone length and shape on bone strength in the Longshanks mouse**

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Anthropologists have long been interested in the relationship between bone strength and morphology, as these traits are functionally related to primate locomotion. The length, shape, and strength of a bone must scale with one another in order to maintain the bone's safety factor. The Rolian lab has been selectively breeding a line of mice ("Longshanks") to have longer tibiae relative to body mass compared to a control cohort. Previous research has demonstrated that the length increase in the Longshanks tibiae resulted in a slight negative allometric change in the bone's shape and cross-sectional dimensions, which may lead to a reduction in the strength of the bone.

The ability of a bone to resist bending is closely related to its cross-sectional dimensions and



## AAPA Abstracts

length. Here we tested the hypothesis that the strength of the Longshanks tibiae has been reduced due to the change in shape and length of the bone. We predicted that, due to their more gracile appearance, the Longshanks tibiae would require lower bending forces to break. Tibiae were dissected from sex-balanced groups from two independent selected lines (n=56), and a control line (n=29). The bones were tested for strength using a three-point bending apparatus, and were broken in the medio-lateral direction. Results indicated that the tibiae in the Longshanks mice required 20-30% less force to break. This research provides insights into the relationship between bone length and strength under directional selection, with implications for the evolution of bone structural adaptations in primates.

**An Analysis of Sexual Dimorphism Using Geometric Morphometrics of the Femur and Tibia; The Use of GM in Assessing Sex of Fragmented Remains**

AMANDA K. COSTELLO. Department of Anatomy and Neurobiology, Boston University School of Medicine.

Biological anthropologists have recently been utilizing geometric morphometrics to investigate sexual dimorphism among modern *Homo sapiens*. To analyze sexual dimorphism of the femur and tibia using geometric morphometrics, landmark data were registered using a Microscribe on 250 individuals of known sex and age at death from the William M. Bass Donated Skeletal Collection. A combination of landmarks and semi-landmarks were collected on the proximal and distal epiphyses of each bone, which captured the overall size and shape variation present in the sample. Classification rates for males (ages 19-96) and females (ages 29-97) for the proximal femur were 80.8% and 78.4% respectively, for the distal femur 92.6% and 89.6% respectively, for the proximal tibia 80.8% and 83.2% respectively, and the distal tibia 81.6% and 80.8% respectively. This study indicates the knee joint is the most dimorphic, followed by the ankle and then the hip. The results are similar to other studies that indicate the knee is more sexually dimorphic, though here it was found the distal femur was the most dimorphic rather than the proximal tibia. This method shows that in comparison to standard measurements, geometric morphometrics may provide a more reliable method for sex estimation when used on the knee. Further research applications will exclude landmarks to determine the usability of the method if fragmented remains are present due to taphonomic processes, such as the case may be in forensic or archaeological circumstances.

**Absence of evidence or evidence of absence? The role of sampling in fossil primate distribution patterns**

SUSANNE COTE. Department of Anthropology, University of Calgary.

Accurate interpretations of the paleoanthropological record require a clear understanding of where and when species lived. Because primates and early hominins are generally rare, they may not always be sampled in fossil collections. Paleoanthropologists must distinguish taxa that are likely to have been truly 'absent' from those that were simply not sampled. Otherwise, they risk ascribing biological meaning to distribution patterns that result from an incomplete fossil record.

Early Miocene localities in East Africa constitute one of the best-sampled fossil primate records known. Fossil catarrhines are patchily distributed across these localities, which some suggest reflects environmental differences, but may also be the result of sampling. To test the effects of sampling on fossil primate distributions, I conducted a complete survey of all catarrhines from the early Miocene localities at Tinderet, Kenya and Napak, Uganda (n = 1164) and used probability-based methods to assess the likelihood that specific primate fossil taxa are truly absent from some localities.

Results indicate that sampling is sufficient only for common catarrhine taxa (e.g. *Proconsul major*), but rare species are not sufficiently sampled to be confident that absences reflect reality (e.g. early cercopithecoids). Localities where primates appear to be absent, such as Bukwa, are poorly sampled and the underlying density of primates in the living community may not have differed from Napak or Tinderet. This case study indicates that we should exercise caution when invoking extinction, migration, habitat change, or other biotic factors to explain the distributions of rare taxa, including both primates and early hominins.

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**Leaps in Tarsier taxonomy: Analysis of skull variations in Tarsiidae using Geometric Morphometrics**

SEBASTIEN COUETTE. PALEVO Lab, Ecole Pratique des Hautes Etudes.

In the two last decades there has been an intense effort to gather new knowledge on *Tarsius*. In addressing tarsier taxonomy and biodiversity, it has been suggested that the number of species to be recognized should be increased from about four taxa to more than 14, and genera from one to three. Most of the time, taxonomic changes and descriptions of new species have been based on a combination of morphological characters, behavioral traits such as vocalizations, computed molecular distances or revised geographic

distributions. To test these hypotheses, we investigated the morphological diversity and disparity of crania in a large sample of tarsiers. We analyzed the cranial variation of 145 specimens allocated in recent taxonomies to nine species, using 3D Geometric Morphometrics. Eighty landmarks were defined on the skulls and generalized Procrustes analysis followed by multivariate statistics were employed. We used a Procrustes ANOVA to test the significance of size and shape differences among the groups. We found significant differences in cranial size and shape between the morphs assigned to genus *Tarsius* and to *Cephalopachus* and *Carlito*, but no significant differences between the two latter sets. Two of the seven species OTUs of the genus *Tarsius* differ significantly from the others. Thus, our analysis of cranial variation indicate the distinction of five morpho-groups. We discuss the definition of species and the impact of our results on tarsier taxonomy. We also comment the impact of the new taxonomic framework for studies of tarsier's diversity, ecology, evolution as well as conservation measures.

**Juvenile body mass estimation: Challenges, issues, and new directions**

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Two attempts have been made to develop body mass prediction formulae specifically for immature remains: Ruff (2008) and Robbins et al. (2010). While both were developed from the same reference population, they differ in their independent variable selection; Ruff (2008) used measures of metaphyseal and articular surface size, whereas Robbins et al. (2010) relied on cross-sectional properties. Both methods perform well on independent testing samples; however, subtle differences between the two methods exist in the predicted values.

This paper evaluates the differences in the body mass estimates from these two methods in seven geographically diverse skeletal samples under the age of eighteen (n=476). The purpose of this analysis is not to assess which method performs with greater accuracy or precision; here, differences between the two methods are used as a heuristic device to focus attention on the unique challenges affecting the prediction of immature body mass estimates in particular. The two methods differ by population only in some cases, which may be a reflection of body proportions, activity variation, or nutritional status. In addition, body mass estimates vary across age categories, as cross-sectional properties almost always produces higher estimates than metaphyseal surface size. This highlights the difficulty in teasing apart information related to body mass from that relevant to loading, particularly when the original reference population is urban/industrial. The comparison to these two methods of



prediction not only provides information about the nature of body mass prediction in juveniles, but also sheds light on issues in immature physiology as well.

**Making physical anthropology "physical" in the online classroom: Digital collections and virtual experiences**

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As higher education evolves more institutions are offering blended or fully online courses. This changing educational landscape may present challenges for anthropologists tasked with building an online course, particularly if their own background as a learner and teacher has focused on the traditional classroom. Designing online courses creates opportunities for working more collaboratively and creatively with colleagues and students. In building online courses, anthropologists can curate rich virtual classrooms from freely available online resources that enhance student engagement and build opportunity for experiential learning. The focus of this presentation is to examine best practices in designing online undergraduate physical anthropology courses. Specific strategies for mapping online content to established course objectives and to varying learner styles will be outlined. To develop and foster student knowledge and critical thinking, basic course content can come to life when paired with media content from colleagues at other institutions, online lab activities and simulations, and digital specimen collections. Assessments focused on experiential learning enhance traditional, text-based course materials and to create opportunities for students to see real world applications of physical anthropology. Experiential activities may include mini fieldwork projects, virtual visits to museums and field sites, and synchronous participation in the events of local professional societies. This best practice enhances student engagement by allowing students to flexibly apply content knowledge in a way that relates to their personal backgrounds or career interests. A virtual classroom that is student-centered and experience driven helps model how professional physical anthropologists engage in fieldwork and scholarship.

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**Simultaneous tracking of wild baboons reveals individual and social drivers of troop organization**

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Primate groups are characterized by marked individual variation, but little is known about how individual differences shape the spatial organization of groups. We studied troop spatial structure of wild baboons by capturing the movements of 25 individuals using high-resolution GPS tracking. Individuals occupied consistent positions within the group across days and contexts. Although internal group structure was partially related to age and sex, individual identity had an even more pronounced effect on positioning, with consequences for the relative exposure of different individuals to the periphery of the group. Spatial structure was also shaped by the underlying affiliative relationships between individuals in the troop. We developed a statistical test to isolate socially-driven associations from proximity due to similar spatial preferences, generating a weighted social network that was stable across days. Combining fine-resolution continuous tracking with network-based analyses gives us deeper insights into how individual and social preferences combine to determine the structure of animal groups.

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**Exploring the Relationship between Territory Size and Mortality from Intergroup Aggression: An Agent-Based Model**

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Animals in many species defend territories, which may provide benefits including food, shelter, and nest sites. Animals are widely assumed to compete for larger territories in order to maximize their access to such limited resources. In some species that defend group territories, such as lions, chimpanzees, and wolves, competition over group territories can be severe, including fatal attacks. One underappreciated benefit of larger territory size is that larger territories should provide protection from intergroup conflict. Here we propose a simple mathematical model for how, in species with intergroup killing, the geometry of larger territory size should reduce the per capita risk of death from intergroup violence, with mortality from intergroup aggression inversely proportional to the territory radius. We tested this

model using computer models and data from chimpanzees. Agent-based computer simulations using territories that were allowed to vary freely in size and shape confirmed the predictions of the geometric model. Under a broad range of parameter values, mortality decreased in larger territories. Using published data on rates of death from intercommunity aggression in 16 chimpanzee communities, we found that the rate of death from intergroup aggression was inversely proportional to the mean territory radius. These findings support the view that in species with lethal intergroup aggression, one simple aspect of territory geometry – size – has strong effects on mortality. In humans, increases in the size of states may be an important factor contributing to documented decreases in rates of war deaths over time.

**Reconstructing the mobility of Madagascar's fauna using strontium isotopes: results and implications for management and conservation**

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Over the past 2000 years, Madagascar has undergone extensive ecological degradation. Deciphering the movement of animals among modern protected, unprotected, and degraded landscapes as well as mobility of individuals in the recent past could help direct management and conservation efforts. Strontium isotope (<sup>87</sup>Sr/<sup>86</sup>Sr) ratios, which predominantly reflect bedrock geology, are able to distinguish organisms from different regions as well as identify highly mobile individuals. We present strontium isotope data for modern plants and lemurs as well as subfossil hippos, lemurs, and carnivores. We find significant differences in <sup>87</sup>Sr/<sup>86</sup>Sr ratios among lithologies. Samples from localities underlain by sandstones, unconsolidated sands, limestones, or lavas have lower and less variable <sup>87</sup>Sr/<sup>86</sup>Sr ratios than those underlain by Precambrian igneous and metamorphic rocks. Modern plants and lemur bone from the same lithologies do not differ isotopically and overall, there are no differences in <sup>87</sup>Sr/<sup>86</sup>Sr between modern and subfossil individuals from the same type of bedrock. However, there are several subfossil individuals that yielded <sup>87</sup>Sr/<sup>86</sup>Sr ratios that are significant outliers for their respective lithologies. We identify these individuals as likely migrants and discuss their potential origins. Our results indicate that Sr isotope ratios can (i) distinguish plants and animals from localities underlain by different lithologies on Madagascar, and (ii) detect mobility of organisms prior to extensive habitat modification. Localities near geological contacts are particularly well suited for strontium provenience techniques. We anticipate that this

geochemical tool could be used to identify historic and recent range restrictions, validate proposed conservation priorities, and identify additional key unprotected areas.

**Mitochondrial haplogroups detected in medieval population from 10<sup>th</sup>-11<sup>th</sup> century on the territory of the West Slovakia**

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Mitochondrial DNA (mtDNA) is often used in archaeogenetical research due to its smaller size than nuclear DNA, the maternally inheritance and higher resistance to physical damage. Because mtDNA does not recombine, we can monitor the mutations which have cumulated over the centuries. Based on combination of these mutations (i.e. haplotype) we can determine haplogroups, which place of origin and extension path are already known. In our study we investigated haplogroups of medieval population from 10<sup>th</sup>-11<sup>th</sup> century using nine skeletal remains from different part and horizons of the cemetery Nitra-Šindolka located in the West Slovakia (Central Europe). Thin sections from femurs were prepared for histological analysis and well preserved bone microstructure was confirmed in all samples. Isolation of DNA, PCR and sequencing reactions took place in the certified archaeogenetical laboratory of Archaeological Institute, Hungarian Academy of Sciences in Budapest (Hungary). We used A (tooth) and B (femur) control of each sample and extraction and amplification blanks. The sequences derived from ancient bones and teeth were analyzed for mtDNA polymorphism using GeneDoc and four haplogroups T, J, U and H were confirmed. We can conclude that the most frequent haplotypes detected in our study belong to haplogroup T (5 samples) and J (2 samples) whereas the most common and widespread European haplogroups H was found only in one sample. Similarly, the second most prevalent European haplogroup U was also detected only in one sample. Two samples (belonging to haplogroup T) have the same haplotype indicating a common maternal ancestor.

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**Extra-large upper molar cusp 5 or double metacone?**

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The present paper discusses the presence and evolutionary consequences of an accessory cusp detected in fourteen individuals from the Prehispanic Maya site of Xcambó (and also noted in some cases in Prehispanic Mixe-Zoque populations in the modern state of Oaxaca, Mexico). It is located in the same position as the upper molar cusp 5, as illustrated in the ASUDAS' cast. Nonetheless, while cusp 5 is expressed as an accessory cusp at the intersection between the metacone and the hypocone, and only in its maximum expression (grade 5) occupies a portion of the area of the metacone, the trait discussed in this paper occupies half (or more) of the extent of the metacone, more likely resembling a double metacone (similar to the double hypocone) rather than a large cusp 5. As an extra-large cusp 5, it would represent the 14.3%, the 57.1% and the 35.7% of all cusps 5 respectively in the first, second and third molars. Instead, if it were considered a double metacone it would be present in 2.7% of first molars, 7.1% of second molars and 5.1% of third molars. Moreover, cusp 5 is more commonly expressed in the upper first molar, while being more rarely found in the second and third molars. On the contrary, the trait discussed here was found in at least four cases both in the first and second molars, or in the second and third molars. Results have implications for typology of traits and for biodistance studies in the region

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**Disease and Biological Stress in Pre-Hispanic Olmos: Uncovering Regional Health Variation at the Fringes of the Middle Sicán Heartland in Northern Peru (A.D. 900-1100)**

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Since 2003, bioarchaeological research on the north coast of Peru has aimed to develop a holistic, contextual, and regional reconstruction of health and social organization within the Middle Sicán state (A.D. 900-1100). Past studies of human skeletons have shown that within the Middle Sicán territorial core, the highest social strata enjoyed significantly superior developmental and adult health, while elevated morbidity was strongly concentrated among low ranked communities. A broader, regional

understanding of Middle Sicán health has been long overdue. A major breakthrough in this direction came about in 2013, when an emergency rescue excavation in the far northern region of Olmos uncovered 81 funerary contexts corresponding to a low status commoner community. We hypothesize that the low-status Olmos peoples also experienced high levels of biological stress. We collected data on cribra orbitalia, porotic hyperostosis, enamel hypoplasias, scurvy, rickets, infectious disease, degenerative joint disease, skeletal trauma, and oral health.

Contrary to expectations, we documented extremely low frequencies of pathological conditions in the Olmos sample. We reject the hypothesis, and consider how biological stress may have been extensively mitigated amongst the low-status citizens in Olmos. A contextual bioarchaeological perspective indicates these outcomes probably emerged from synergisms between ecogeography and relative political autonomy. This research contributes to the ongoing reconstruction of the socioeconomic and regional dimensions of health in Middle Sicán society. Stress and disease were neither monolithic nor socially predestined, but produced by dynamic, socioeconomic forces that are just beginning to be better understood amongst the peoples of ancient Peru.

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**The forgotten pathology: Middle ear disease at Mount Nebo, Jordan**

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The temporal bone is often overlooked during a paleopathology exam, yet it houses important organs for hearing and balance, which can greatly affect quality of life and standard of living. This research evaluated evidence of ear disease in the temporal bones of comingled monastic remains from Robebus Crypt, from the Byzantine period in Mount Nebo, Jordan.

A total of 56 right and 51 left temporal bones, associated with 5 skeletons and 49 skulls, were examined; 58 temporal bones (29 right and 29 left) were paired. Gross examination, endoscopy and microscopy were utilized to assess external and internal temporal bone pathology. The results revealed the presence of abnormal mastoid air cell pneumatization (46%), ossicle erosion (62.5% incudes and 17% stapedes), stapedia footplate fixation (3%), and mastoid lesions (33%).

The presence of abnormal air cells, ossicle erosion and stapedia footplate fixation is

indicative of chronic middle ear disease, which develops when fluid fills the middle ear. This leads to hearing loss and language delays in children, and is often accompanied by pain and fever, affecting normal activity. One case of stapedial footplate fixation was in a skull with possible Paget's disease, and supports this diagnosis. The mastoid lesions resulted from incomplete fusion of the squamo-mastoid suture, known as Korner's septum; although etiology is still unknown, the clinical literature suggests a link with middle ear disease. Temporal bone paleopathology is an overlooked examination area that contains several key diagnostic features for understanding the impact of hearing loss and ear disease on a population.

#### Cortical Bone Loss and Osteoporotic Fractures in the Coimbra Identified Skeletal Collection

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Cortical bone loss and osteoporotic fractures in an identified skeletal sample from the Natural History Museum at the University of Coimbra (N=196; ♀: 98; ♂: 98) were studied. Conventional radiogrammetry was used to assess cortical parameters (diaphysis total width [DTW], medullary width [MW] and cortical index [MCI]) at the second metacarpal midpoint. Osteoporotic fractures (vertebrae, hip, distal radius and proximal humerus) were also evaluated. MCI is significantly higher in males (♀: 48.4; SD=11.9 / ♂: 56.1; SD=11.2). As expected, MW (♀: Pearson's  $r = 0.544$ ,  $p < 0.001$  / ♂: Pearson's  $r = 0.209$ ,  $p = 0.043$ ) increases with age (at death), while MCI (♀: Pearson's  $r = -0.582$ ,  $p < 0.001$  / ♂: Pearson's  $r = -0.212$ ,  $p = 0.036$ ) significantly decreases with age in both sexes. There is no linear relationship between DTW and age (♀: Pearson's  $r = 0.080$ ;  $p = 0.454$  / ♂: Pearson's  $r = 0.036$ ;  $p = 0.728$ ). The frequency of osteoporotic fractures is 15.3% (30/196), without significant differences in fracture prevalence between sexes (♀: 16.3% [16/98] / ♂: 14.3% [14/98]). While univariate analysis suggests that MW and MCI are significantly lower in fractured women, logistic regression shows that only age is associated with osteoporotic fractures in the females' group ( $B_{age} = 0.064$ ; Wald=11.406;  $p = 0.001$ ). In the males' group, older age and higher values of DTW are associated with fractures, both in univariate analysis and logistic regression models ( $B_{age} = 0.039$ ; Wald=4.220;  $p = 0.040$  and  $B_{DTW} = 1.206$ ; Wald=6.589;  $p = 0.001$ ).

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#### Taphonomy of Hominin-bearing Middle Pliocene Localities at Woranso-Mille, Ethiopia

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To fully understand the environments in which hominins evolve, it is necessary to first understand the taphonomy of the sites from which hominin remains are recovered. In this study we identify the accumulator(s) of two localities from Woranso-Mille, a Mid-Pliocene hominin-bearing site in the central Afar region of Ethiopia. Since the oldest *Australopithecus afarensis* specimens thus far found come from this site, elucidation of its taphonomic context is imperative to our understanding of the origins of this taxon.

Materials included in this analysis are derived mainly from walking surveys, except two test squares where every fossil specimen was analyzed. For the rest of the analyses included here, specimens were collected mainly from surface contexts, though fossils were sometimes found in situ. Taxon representation, skeletal elements present, bone breakage patterns, and bone surface modifications, with special focus on scores and pits, were analyzed for assemblages from the Aralee Issie and Mesgid Dora localities.

These assemblages are dominated by Cercopithecoidea, with *Theropithecus darti* being the most frequently identified species. Dental elements make up the majority of the assemblages. Surface modifications and breakage patterns are mainly those associated with abiotic, post-depositional alterations. Dental elements are heavily pitted. Post-cranial elements have irregular breaks and are pitted, though less so than dentition. Scores and tooth pits are extremely infrequent in these assemblages. Thus, it is unlikely that hominins or carnivores contributed to the accumulation of remains at ARI and MSD. Instead, all evidence points to an attrition assemblage that was mainly altered by post-depositional processes.

#### Ecomorphology and locomotor adaptations of small mammals: implications for habitat inferences of Shuitangba (Yunnan, China), a late Miocene hominoid-bearing site

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The ecomorphology and locomotor adaptations of past organisms are often used to make

inferences about their paleoenvironment. Most studies have focused on large mammals, but small mammals can also provide valuable insights into the paleoenvironment of interest given their small range size and habitat sensitivity. This study seeks to identify reliable correlations between bone morphology and locomotion in extant small mammal species in order to predict the behavior of fossil specimens and, ultimately, to reconstruct their paleohabitats.

The modern comparative sample (n=212) includes 29 rodent and 5 lagomorph genera and represents 7 distinct locomotor groups. Mosimann shape variables and functional indices were computed from 35 caliper measurements of the appendicular skeleton. Step-wise discriminant analyses identified 15 shape variables and 10 functional indices that best distinguish among locomotor groups. The majority of these variables reflect relative robusticity of joint surfaces and muscle attachments. Intermembral and brachial index also discriminate well, though their utility is limited to associated postcranial remains. Results of canonical variates analysis demonstrate 93.8% and 83.1% accuracy of reclassification (cross-validation) for shape variables and functional indices, respectively.

The latter method is applied to the micromammal fauna of Shuitangba, a late Miocene hominoid-bearing site in China. The results revealed a variety of locomotor types represented in the small mammal fauna, including semi-aquatic, arboreal, fossorial and ricochetal, indicating a wooded habitat and the presence of a water source. These results corroborate paleoenvironmental reconstructions of the site based on other lines of evidence, such as paleobotanical remains and avifauna.

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#### Morphometrics and plantar pressure in indigenous Brazilians

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Most of our insight into modern human locomotion is based on Western subjects, but recently, populations from Asia and Africa have also been subject of research. Dynamic locomotor data from indigenous South-Americans are, however, lacking.



## AAPA Abstracts

Brazil is home to approximately 200 indigenous ethnic groups, occupying different habitats, and thus provides an excellent case to gain an insight in modern human variation and, potentially, locomotor related form-function relationships. We present an exploratory data set consisting of morphometric data, spatiotemporal gait characteristics (lateral video, 120fps), and plantar pressures (Tekscan HR, 285fps) for 23 male and 13 female subjects (10 Xavante, 9 Gavião, 7 Guajajara, and 10 individuals from 5 other groups; age  $32 \pm 6$ ). Three left and three right foot trials were collected per subject at the Bioengineering and Biomechanics Laboratory of the Federal University of Goiás, and consisted of walking at preferred velocity.

The subjects were relatively short and heavy (stature,  $1.61 \pm 0.08$ m, BMI,  $30.3 \pm 4.7$ ) and had a leg length (trochanter major to ground) of  $0.83 \pm 0.06$ m and a navicular height (half weight bearing) of  $45 \pm 10$ mm. 7 Subjects reported to walk barefoot for a substantial proportion of time; the others habitually wore flip-flops or (sometimes) trainers. Morphometrics and plantar pressure data show a relatively wide forefoot region, but plantar pressure characteristics (spatial distribution and centre of pressure roll-off) are overall similar to Western populations. Future work will focus on exploring variation between Brazilian ethnic groups.

#### Estimating body size in early primates: the case of *Archicebus* and *Teilhardina*

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*Archicebus achilles* and *Teilhardina belgica* are among the earliest Eocene primates so knowledge of their paleobiology is crucial to our understanding of early primate evolution. Since body mass is often a key to evaluating other important aspects of paleobiology determination of the likely body mass of these early primate taxa is a significant task for paleoprimatologists.

These particular taxa pose several interesting problems for body mass estimation. First, they are at the far small end of body size distribution of living primates. Secondly, they are not nested within any family of living primates but lie at or near the base of the tarsiform radiation. Thirdly, their nearest living relatives (tarsiers) are highly derived dentally, cranially, and postcranially. All of these raise the question of how to choose an appropriate reference group. In addition *Archicebus*, although represented by many

skeletal elements, is a sample of one while *Teilhardina* is represented by more individuals but fewer different skeletal elements.

Using samples of extant strepsirrhines, tarsiers, and anthropoids to construct bivariate and multiple regression models we investigated the effects of choice of reference population (different size ranges and different phylogenetic groups) on estimates of body mass in these fossil taxa. We conclude that even the best statistical estimates have wide confidence intervals which need to be taken into account if body mass is used to predict other aspects of the fossil taxon's behavior and ecology.

#### A Comparative Study of the external genitalia of female Hylobatids: Adolescent *Nomascus* masquerade as males

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Monogamy is relatively uniform within hylobatids but the external genitalia of females vary in structure and response to hormones. In particular, female *Nomascus* are characterized as having a peniform clitoris, and a membrane has been shown to occlude the vulva. To verify this diversity, a comparative study was made of living representatives of four genera: *Nomascus* (n=9); *Bunopithecus* (n=4); *Symphalangus* (n=3); *Hylobates* (n=8). Using head and body length to obtain relative sizes, the Relative Ano-Genital Distance, RAGD, was taken as a measure of masculinization and compared with the relative length of the external clitoris (RCL). Results showed that adult *Nomascus* have a longer anogenital distance (RAGD = 7.0) than the other genera (RAGD = 4.5). They exhibit a relatively long clitoris (RCL = 2.3) compared to the sessile clitoris of *Hylobates* (RCL = 1.3) but this was similar to those of *Bunopithecus* (RCL = 2.3) and *Symphalangus* (RCL = 2.75). The clitoris of adolescent *Nomascus*, however, was found to be truly peniform (RCL = 4.0) and a membrane occluded the vulva so the genitalia appear to be male and intromission impossible. Resemblance to the male is enhanced by young females exhibiting the black pelage of the male rather than the golden-brown of the adult female. To masquerade as a male and prevent vaginal penetration may contribute to a female's ability to extend its adolescence within the natal group while minimizing incestuous attention from male relatives and aggressive attention from the mother.

*This research was supported by the Gibbon Conservation Center, Los Angeles Zoo, Cheyenne Mountain Zoo, Denver Zoo, and Americas Teaching Zoo at Morepark College provided key access to study subjects.*

#### An intraspecific analysis of the inhibitory cascade (IC) model in gorillas, chimpanzees, and modern humans

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The inhibitory cascade (IC) model asserts that activator and inhibitor molecules regulate size and timing of sequentially developing teeth. The model provides a set of predicted outcomes from reduced-major-axis (RMA) regressions of molar crown area ratios (i.e.,  $M_2/M_1$ ,  $M_3/M_1$ ) and has been successfully applied in some mammals. A previous interspecific analysis demonstrated that mean tooth proportions from catarrhine mixed primary postcanine (MPP) dentitions (i.e.,  $dp_4/dp_3$ ,  $M_1/dp_3$ ) also adhere to the IC model (i.e., slope=2.0, intercept=-1.0). Since molars and the MPP row both belong to the primary dentition, we expect that hominoid tooth proportions calculated from either postcanine series should also fit the IC model.

We tested the model fit for both molar and MPP tooth rows within individuals from each hominoid species (*Pan troglodytes*, *Gorilla gorilla*, and *Homo sapiens* (n=136)). We collected linear measurements from mandibular postcanine teeth to calculate maximum occlusal areas and molar or MPP ratios. Using RMA, we found that the MPP dentitions fit the IC model, with slopes not significantly different from 2.0 (*H. sapiens*: 1.73,  $p=0.106$ ; *G. gorilla*: 2.12,  $p=0.79$ ; *P. troglodytes*: 2.35,  $p=0.53$ ) and y-intercepts not significantly different from -1 (*H. sapiens*: -0.634,  $p=0.35$ ; *G. gorilla*: -1.01,  $p=0.56$ ; *P. troglodytes*: -1.16,  $p=0.15$ ). Although gorilla molars did fit the model (slope=1.51; y-intercept=-0.62), the  $R^2$  was not significant ( $p=0.19$ ). Human (slope=-1.11; y-intercept=2.0) and chimpanzee (slope=1.06; y-intercept=-1.16) molars deviated significantly from the IC model. These results suggest that for hominoids the IC model is most robust in the earliest initiating teeth, such as the MPP dentition.

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#### Reevaluating the relationship of the bicondylar angle to dimensions of the pelvis and femur

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The femoral bicondylar angle characteristic of humans and fossil hominins is an adaptation for bipedal gait, as it places the foot closer to the midline, below the body's center of mass, during stance phase. Ontogenetic studies have shown



that during early development the bicondylar angle consistently covaries with other variables related to bipedal gait and stance, such as pelvic breadth and femoral length. Although the large bicondylar angles of *Australopithecus africanus* and *A. afarensis* have been attributed to their broad pelvis and short stature, the relationship among these variables has not been well tested in adults. In this study, pelvic breadth, femoral length, femoral neck length, and the cervico-diaphyseal angle were measured to determine which variables are correlated with the bicondylar angle in an adult human skeletal sample (n= 86). Results indicate that none of the measurements examined here are significantly correlated with bicondylar angle among adults. Femoral neck length is positively correlated with total femoral length across the sample. Pelvic breadth and femoral neck length are positively correlated in females. Males display a positive relationship between femoral length and biacetabular breadth, pelvic breadth and neck angle, and neck length and neck angle. However, these results do not support the assertion that a wider pelvis and short stature (or femora) predicts a larger bicondylar angle among adults. These results weaken previous interpretations of bicondylar angle in fossil hominins and have implications for interpreting lower limb skeletal adaptations and locomotor mechanics in the hominin skeletal record.

**Leanderthal Remix: a virtual reconstruction of a remarkably complete skull from the Paleolithic period of central Texas (~10,000 BP) using high-resolution X-ray CT**

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Questions concerning the biological affinity of the earliest Americans have long been of great interest to physical anthropologists. Morphological investigations often focus on cranial and/or dental similarities in order to establish probable biological relationships, and previous workers have concluded that, broadly speaking, Paleoindians most closely resemble modern Asians. However, finer resolution of the issue is hampered by a lack of sufficiently complete human remains of sufficient antiquity that can potentially shed more light on the issue. The Wilson-Leonard II (WL-II) burial from central Texas is one of ~10 mostly complete adult human skeletons from North America confidently dated to ~10,000 BP or older. Unfortunately, while the skull of WL-II is nearly complete, it was compressed to approximately 1/3 its original M-L width. A forensic sculptor provided a reconstruction, but it was not done in a manner to allow accurate anatomical measurements. The present study uses high-resolution X-ray computed tomography (CT) data to reconstruct the skull of WL-II in order to obtain reliable cranial measurements which can be used to examine the degree of similarity to

Paleoindians of comparable age and to other Late Pleistocene/Holocene populations from Asia, Europe, and the Americas. Results verify previously identified trends in Paleoindian cranial morphology (i.e., longer, narrower braincases; small, relatively narrow, and somewhat prognathic faces) and support the assertion that Paleoindians are broadly similar to a generalized Asian stock, at least in terms of cranial morphology. Implications for Paleoindian biological affinity and competing theories of the peopling of the Americas are discussed.

**Incisor variation at middle Miocene Maboko indicates the possible presence of at least two small-bodied ape species**

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The hypodigms and taxonomic classifications of Early and Middle Miocene small bodied apes from Uganda and Kenya are under constant revision and rearrangement. This is largely due to the incomplete nature of the material and the relatively small number of teeth associated in maxillae and mandibles. For species where no associated incisors are known, isolated ones are attributed to them based on inference.

A small collection of small-bodied ape permanent and deciduous incisors was discovered during the excavation of in situ sediments at ~15 my Maboko Island between 1987 and 1997. The sample of ten I<sup>1</sup>s are slightly smaller than *M. clarki* from Napak and therefore are currently the smallest known for any small-bodied ape species. Six of these I<sup>1</sup>s are attributed to the more common species at Maboko which is presently called *Micropithecus leakeyorum*. They are characterized by an asymmetrical crown and a low and asymmetrical V-shaped lingual cingulum that is longer and taller on the mesial than distal side, most similar to *Pliopithecus vindobonensis*. An additional four specimens appear to belong to a different type and/or species with a more symmetrical crown and a U-shaped lingual cingulum most similar to NAP XV 65'09, currently attributed to *Karamojapithecus akismia* (they are less like other specimens attributed to that species). Two small-bodied ape species may therefore be present at Maboko, one with upper central incisors more similar to *Pliopithecus* and the other with a morphology more consistent with other East African small-bodied apes.

**Prehistoric motherhood: diet from pregnancy to baby-led weaning in the Danube Gorges Mesolithic-Neolithic**

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The Danube Gorges Mesolithic-Neolithic sites (ca. 9500-5500 BC, Balkans) offer a unique osteological collection including well preserved young children (26 gestational weeks to 9 yrs old) discovered in a specific archaeological context (eg. association with adults, deposit of ochre, burial under house floor). This collection provides the opportunity to tackle the issue of Prehistoric motherhood, of particular importance during this period of demographic transition and subsistence changes. Indeed, the quality of nutrition during the pregnancy and the weaning practices have an important influence on females' fertility and a major impact on the survival of the babies. Our paper presents a multi-sampling strategy (bone, deciduous and permanent teeth) and new multi-element stable isotope data (carbon, nitrogen, sulfur on collagen) from 64 immature individuals from the sites of Padina, Vlasac, Lepenski Vir, Hajdučka Vodenica and Ajmana, located in the right bank of the Danube river. From the results we discuss for the first time longitudinal dietary changes occurring from the pregnancy stage to breastfeeding and baby-led weaning. Compared with previous published data (neonates and adult females), our multi-element stable isotope results allow us to assess specific dietary strategies during pregnancy. Moreover, these new results indicate significant subsistence differences between the Mesolithic children buried inside the Gorges (diversified and mixed diet) and the Early Neolithic ones discovered in Ajmana (mainly meat-based diet) at the entrance of the Gorges. This study opens new prospect regarding both diet and physiology during pregnancy and cultural effects on dietary behaviors during childhood.

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**A strontium isotope perspective on catchment area and intra-site subsistence variation**

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Aside from determining the degree of non-local origin for members of a mortuary population, strontium isotope composition in tooth enamel is an approximation of the local, bioavailable strontium. In turn, the strontium isotope variation in the local population is a measure of the site catchment used by that local population over time. Here we show that the relationship between the isotopically indicated catchment is directly proportional to the number of local individuals for the eight near-contemporaneous-or-succeeding Corded Ware, Bell Beaker and Únětice sites from the bundesland of Saxony-Anhalt, Germany. Results show that the isotopic approximation of site catchment scales to population, and thus serves as an indicator that mode of subsistence was flexible and scale-able in the Late Neolithic/Early Bronze Age.

**Access to electric light is associated with shorter sleep duration in Toba communities of the Argentinean Chaco**

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It has been postulated that, in humans, access to electric light changed the ancestral timing and duration of sleep. To test this hypothesis, we compared sleep patterns in two indigenous Toba communities in the Argentinean Chaco. These communities are located 50 km apart from each other, share the same ethnic and sociocultural background, but have, respectively, no access or free access to electricity. We fitted youth and adult participants in each community with wrist activity data loggers to assess their sleep-wake cycles during one week in the summer and one week in the winter. During the summer, compared to participants living under natural light conditions, participants with access to electricity had a tendency to a shorter daily sleep bout (43 min, n = 6 per community). This was in line with a statistically later daily bedtime and sleep onset in the community with electricity but a similar sleep offset and get-up time in both communities. In the winter, participants in the community without access to electricity had statistically longer daily sleep durations (56 min, n = 8 and 11, for non-electricity and electricity communities, respectively) and this was also due to later bedtimes and sleep onsets than participants in the community with electricity. Furthermore, in both communities, daily sleep duration was statistically longer during the winter than during the summer. Our results in a historically hunter-gatherer community suggest that the ancestral human sleep pattern was likely

modified by our ability to create protected, artificially lit environments.

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**Quantitative Analysis of Variation in Molar Crown 'Flare' in Modern Humans and Chacma Baboons**

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Among the features that are held to differentiate *Australopithecus anamensis* from *A. afarensis* is the possession by the former of molars with lower crowns and more sloping buccal and lingual sides. Similarly, it has been argued that there are two species of *Australopithecus* represented at Sterkfontein, and that the "second" differs from *A. africanus* in having bulbous molars with the cusp apices situated towards the crown center. This descriptive trait of crown wall slope, or 'flare', has not been quantified in these fossils, and nor has it been studied in extant primate species.

As a first step to evaluating the possible cross-sectional shape differences among extinct hominin species, we examined relative crown height and the flare of cuspal walls in the permanent molars of recent *Homo sapiens* (n = 64) and *Papio ursinus* (n = 59). Low magnification micrographs of cross sections through the mesial cusps were used to define a series of landmarks at the cusp tips, dentine horn apices, and cervical margins. Linear measurements, indices and angles defined by these landmarks were used to study the metameric variation in molar 'flare' in both species samples.

Results indicate that while there are no significant metameric differences along the molar row in humans, in *Papio* there are such differences. In addition there are differences between maxillary and mandibular molars at the same position in both species.

This study provides a framework that is necessary for further analysis of the taxonomic utility of this dental trait.

**Anthropoid incisor crown bending strength and dietary mechanical loading: What's curvature got to do with it?**

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Anthropoid incisors play a prominent role in the pre-processing of food items prior to ingestion and are strongly influenced by dietary mechanical loading. It has been demonstrated that incisal curvature (mesiodistal and cervico-incisal) is positively correlated with a proportionate increase in frugivory. Hard-object frugivores have greater maxillary incisal curvatures than soft-object frugivores, and mixed folivore/frugivores exhibit intermediate degrees of mesiodistal and cervico-incisal curvature relative to frugivores and dedicated folivores who are the least curved. Despite a demonstrated potential for increasing dietary resolution in analyses of extant platyrrhines and extant and early Miocene fossil hominoids, analyses of incisor curvature are presently limited as the functional basis for curvature variation has yet to be conclusively established.

The research described here attempts to establish the functional significance of incisal curvature variation by testing the hypothesis that any increase in labiolingual crown dimensions will result in a proportionate increase in crown bending strength. Incisors representing extant hominoids and platyrrhines (n=187) with well-understood diets were modeled as cantilevered beams and maximum bending and shearing strength was calculated in both the mediolabial and labiolingual axes. A similar analysis of early Miocene fossil hominoids (n=76) for which diet has been reconstructed multiple times using a variety of methods was also completed. Results indicate that incisal bending strength closely tracks diet in all three groups and that incisal curvature is positively correlated with a proportionate increase in crown bending strength. This suggests that incisor crown curvature functions, at least in part, as a mechanism for resisting crown fracture.

**What counts in the end? - Determining the MNI for the commingled and fragmented bone assemblage from the Middle/Late Bronze Age Tomb VII, Qatna (Tell Mishrife, Syria)**

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An undisturbed rock-cut burial chamber (Tomb VII) of approximately 32 m<sup>2</sup> ground size was found underneath the royal palace of the Bronze Age city of Qatna, Syria. Archaeological analyses suggest that the tomb was in use over several centuries. Thousands of fragmented and commingled human bones representing individuals of all age groups and sexes were scattered on the floor. Lines of decayed wood surrounding some of the bone accumulations

were interpreted as remnants of wooden boxes originally serving as bone repositories.

Reconstructing the minimum number of individuals (MNI) within smaller areas ("boxes" and areas in between) and the tomb in total is crucial for an understanding of ancient burial rites and the taphonomy of the tomb.

Calculation of the MNI was based on adult skeletal elements and the presence of additional elements from individuals of different non-adult ages.

Calculated MNIs in 15 areas (total 21 areas) varied between four and 16. In sum, an MNI of 123 was calculated in these areas. However, calculations were based on different skeletal elements and it cannot be excluded that individual skeletons were scattered over several areas. Therefore, a calculation based on the most frequent element (left talus) for the complete tomb was performed, leading to an MNI of 79.

Given the complex taphonomic situation in Tomb VII, calculating MNIs contributes to the understanding of the way it was used. Our results suggest that skeletons were distributed within the tomb. This indicates that bones were (repeatedly) moved when storing additional bones or individuals.

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#### Changing perspectives: Ontogeny of facial orientation and eye hypertrophy in tarsiers

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The remarkable skull of *Tarsius* is an economical package of extraordinary specializations that optimizes input of a high-definition audiovisual system, maintains head carriage to accommodate efficient VCL lifestyle, and supports a predaceous feeding mechanism. Here, we investigated cranial integration of these systems during growth. Based on the expected conservation of cranial base (CB) morphology, we hypothesized that the extreme increase in eye size through postnatal growth would be associated with reorientation of the facial skeleton and dentition relative to a stable CB.

We created digital reconstructions of the skull, dentition, semicircular canals (SCCs), and eye in fetal, perinatal, and adult *Tarsius syrichta*, and comparative samples of strepsirrhines and anthropoids. Reconstructions employed microCT data, histology, and gross anatomic study. Spatial

relationships were quantified using landmark coordinate data. In addition, we estimated visual, occlusal, and lateral SCC planes in each specimen.

Contrary to our expectations, eye hypertrophy in the tarsier appears to be accommodated in the skull by superior and posterior translation of the anterior cranial base. The position of the dentition relative to the posterior CB is more stable than predicted. This may relate to timing of eye hypertrophy in tarsiers, which occurs postnatally and *after* vestibular and masticatory systems have been established. In contrast, the visual plane rotates dorsally relative to the posterior CB as the eye grows. If we assume that the visual plane is parallel to the horizon, then head carriage in the tarsier must be characterized by ventral rotation of the skull relative to the torso.

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#### Analysis of incisor microwear in five genera of platyrrhine primates

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Platyrrhine species vary in the extent and manner in which they use their incisors during ingestion. To determine whether such differences are reflected in patterns of microwear, casts of wild collected specimens from the American Museum of Natural History and the Museu Goeldi were analyzed using white-light confocal profilometry and scale-sensitive fractal analysis. Microwear textures were characterized on the labial surface of the maxillary central incisor for *Ateles* (n = 19), *Cacajao* (n = 5), *Chiropotes* (n = 15), *Pithecia* (n = 26), and *Callicebus* (n = 23). Significant differences were found for textural fill volume (*Tfv*), a measure of microwear feature size. Among the pitheciines, *Chiropotes* has the highest *Tfv* and *Pithecia* the lowest, which is consistent with observations that *Pithecia* tends to eat fruits with a lower resistance to puncturing than *Chiropotes*. Additionally, *Tfv* is significantly higher for *Callicebus* than *Ateles*, which is consistent with *Callicebus* employing its incisors more frequently to ingest husked fruits. Few studies of primate incisor microwear texture have been performed to date, but results from studies conducted on bioarcheological collections suggest that standard texture variables, which commonly separate molar samples by diet (e.g., surface complexity and anisotropy), may not be as useful for incisors, at least not in groups considered so far. On the

other hand, *Tfv* seems to have more potential for discriminating between groups that differ in the habitual use of their incisors.

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#### Investigating the impact of cranial modularity on hominin phylogenetics through Bayesian analysis of partitioned character matrices

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It has been suggested that certain regions of the hominin skull are more reliable sources of phylogenetic information than others. However, empirical tests of this hypothesis have yielded conflicting results: some have supported it, while others have not. Here, we report a study in which we used a relatively new approach—Bayesian analysis of partitioned character matrices—to revisit the hypothesis. Developed by biologists to allow multiple genetic loci to be used to infer phylogenies, Bayesian analysis of partitioned character matrices involves applying different models of evolution with unlinked parameters to different subsets of characters.

We compiled a data matrix from published sources. We then ran a Bayesian analysis with the data partitioned into four functional modules (face, mandible, neurocranium, and dentition) and several parameters unlinked across the partitions. We tested the fit of the partitioned model by comparing its likelihood to the likelihood of a randomly partitioned matrix. The comparison was based on Bayes factors, which is a ratio of marginal likelihoods of two models.

We found an improvement in the likelihood value for the functionally partitioned dataset (BF=2.87) when we unlinked the gamma and state frequency parameters and allowed the rate of evolution to vary across partitions. However, this improvement was very modest, which suggests that the modules do not in fact have different evolutionary trajectories. As such, our study does not support the hypothesis that certain regions of the hominin skull are more reliable sources of phylogenetic information than others.

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### Chimpanzee bipedal gait mechanics and early hominin gait evolution

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Striding bipedal walking with the center of mass (CoM) vaulting over the stance foot is a hallmark feature of humans. Here we present data on the CoM mechanics of the facultative bipedal gait of our closest living relative, the chimpanzee, in order to shed light on the gait mechanics of the last common ancestor and early hominins. CoM oscillations were documented for 81 bipedal walking strides of three chimpanzees. Full-stride ground reaction forces were recorded as well as kinematic data to synchronize force to gait events and to determine speed. Despite being a bent-hip, bent-knee gait, chimpanzee walking employs pendulum mechanics with vertical oscillations of the CoM that are similar in pattern and relative magnitude to those of humans. Maximum height is achieved during single support, minimum height during double support. The mediolateral oscillations of the CoM are more pronounced than in human walking. Despite the pendular nature of chimpanzee bipedalism, energy recoveries from exchanges of kinetic and potential energies are low and highly variable. This variability is probably related to the poor phasic coordination of energy fluctuations. The pronounced side sway is not passive, but constitutes 10% of the total work of lifting and accelerating the center of mass. CoM oscillations of bipedally walking chimpanzees are distinctly different from those of 'chimpanzee-like' bent-hip, bent-knee gait of humans with a flat CoM trajectory, thereby limiting insights to be gained from such a gait for hominin evolution. The last common ancestor was probably capable of supporting and accelerating an oscillating CoM.

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### Early modern humans and morphological variation in Southeast Asia: fossil evidence from Tam Pa Ling, Laos

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Despite its geographic primacy as the intersection of dispersal paths to Australasia, mainland Southeast Asia has played little role in scenarios of early human migrations. Tam Pa Ling (TPL), Laos, is the source of early modern human fossils – a partial cranium (TPL1) and a complete mandible (TPL2) – that have been recovered from a secure stratigraphic context dated to 45-63 thousand years ago (ka). These fossils represent the earliest anatomically modern humans in continental Southeast Asia and introduce new migration routes into the region during Marine Isotope Stage (MIS) 3.

The TPL fossils were evaluated in the context of archaic and early modern humans from across the Old World with an emphasis on available fossils from East and Southeast Asia. The TPL1 partial cranium and TPL2 mandible were evaluated using discrete traits, linear and angular morphometrics and geometric morphometrics. Between-group principal component analysis was performed to evaluate shape differences between *a priori* defined comparative samples and to determine the affinities of the TPL fossils. While the TPL1 cranium demonstrates affinities with early modern humans in all features, the TPL2 mandible shows a mixture of archaic and modern traits and is aligned with archaic humans in geometric morphometric analyses. These results are evidence that fully modern morphology (TPL1) was present in Southeast Asia prior to or contemporaneous with a mixture of archaic and modern human anatomy (TPL2), suggesting that a large range of morphological variation was present in early modern human populations residing in the area.

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### Optimal foraging and ephemeral group formation of two societies on the boundary of theory

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Humans frequently form short-lived cooperative groups to accomplish subsistence and economic tasks. We explore the ecological and cultural factors behind ephemeral work-group formation

in two disparate cultural contexts: groups foraging for wild honey in present day South India and groups prospecting for silver ore in the Elk Mountain Mining District of Colorado in the late 19th Century. Contrary to traditional economic foraging predictions, we find little evidence that per capita yields are the most important factor in determining size and composition of ephemeral work groups. We explore factors in each of these cultures that may be of importance in group formation such as kinship, reputation, and pleasure. Models that only incorporate economic parameters will make poor predictions of how humans interact with their environments.

### Brains, birth, bipedalism and the mosaic evolution of the helpless human infant

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African ape mothers experience a relatively easy birth after which the infant clings to her mother exclusively for several months. The human experience is vastly different. After an often difficult and long labor, the human newborn emerges helpless, and requires active transport and constant care from the mother, who benefits from the help of others. How and when did these changes in childcare happen? The percentage of the adult brain size achieved by birth distinguishes altricial mammals from precocial ones. Though primates fall within the general precocial mammal trend, humans differ in having one of the least developed brains of any precocial mammal. Estimates of brain size at birth in hominins reveal that the trend toward helplessness was gradual, beginning in the Pliocene and reaching the modern human condition by the Late Pleistocene. Furthermore, intragroup tolerance and some minimal form of alloparenting may have been present in Pliocene hominins since bipedalism both reduces pedal grasping and turns the gravity vector 90°, eliminating dorsal riding as an infant carrying option in pre-technological australopiths. Given regression-based calculations that australopith infants were relatively large, and paleobiological evidence that female australopiths would have to have occasionally taken refuge in trees to forage or avoid predation, infants would have been much more likely to survive if their mother received assistance from other members of the group. Thus, some of the behavioral adaptations that allow modern humans to rear energetically expensive, overlapping dependent, offspring, may have deep evolutionary roots.

### Differential maternal investment in rhesus monkey mothers with hair loss in the neonatal period

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Rhesus monkeys frequently show significant hair loss late in the peripartum period and regain full coats when their infants are a few months old. While pregnancy is a known risk factor for the occurrence of alopecia, the relationship between hair loss, chronic hormone circulation, and maternal investment is not understood. We tested the hypothesis that hair loss in pregnant females is associated with greater infant investment in 41 female rhesus monkeys (*Macaca mulatta*) throughout the 2013 birthing season at the Laboratory of Comparative Ethology at the NIH Animal Center in Poolesville, MD.

We analyzed 1) photographs for alopecia severity and hair samples for chronic cortisol in April (pregnancy), July (early lactation), and October (late lactation), as well as 2) fetal measurements via ultrasound in pregnancy and 3) milk yield volume (MYV) and infant growth rate (g/day) in the neonatal period (first 30 days). We found that the severity of hair loss in early lactation was predicted by higher HCCs in pregnancy ( $R^2=0.16$ ,  $p=0.01$ ). Moreover, mothers with hair loss has smaller fetuses than those with normal coats ( $p<0.01$ ), but showed significant positive correlations between HCCs in pregnancy and both MYV ( $r=0.84$ ,  $p<0.01$ ) and infant growth rate ( $r=0.66$ ,  $p<0.05$ ) in the neonatal period whereas mothers with normal coats showed no such relationship. These findings suggest that 1) maternal cortisol may program milk production and therefore infant development, and 2) that mothers who are already constrained may be saving their resources for the early neonatal period rather than the prenatal period.

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**Surviving a suspected chimpanzee attack: Documentation of limb amputation in a wild *Cercopithecus* monkey**

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There are numerous reports of trauma and healing from field studies of non-human primates. Likewise, museum skeletal studies have documented healed fractures as being relatively common in most groups of non-human primates. However, in wild environments, it is often difficult to know the cause of traumatic

injuries, and how individuals survive. Here, we provide a case report on an adult female *Cercopithecus* monkey who survived life-threatening trauma after a successful chimpanzee predation event occurred in her social group. The study group represents a unique population of *Cercopithecus mitis*, *C. ascanius*, and *C. mitis* x *C. ascanius* hybrids in Gombe National Park, Tanzania. On October 9, 2013, we observed chimpanzees in our study group's home range eating a freshly killed *Cercopithecus* monkey. For the next two days, we encountered chimpanzees in the study group's home range, and on the morning of October 11<sup>th</sup>, we observed Zalia, a habituated *C. mitis*-like female, with an injury to her left arm. She could not move her arm, and photographs document the progression of the injury from normal appearance of the immobile arm to swelling and skin dehiscence to auto amputation of the forearm. Although we did not observe directly the cause of the injury, we suggest it was caused by predation. By early February 2014, skin and hair had grown over her stump and she appeared to be fully recovered from the injury. This account provides a unique example of an adaptive physiological response to skeletal trauma in wild primates.

**Moderate cold stress does not alter bone architecture in growing mice: Implications for human skeletal variation**

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Humans exhibit substantial ecogeographic variation in bone size and shape, perhaps due in part to the effects of temperature on skeletal acquisition. Cold stress should induce bone loss via increased sympathetic tone. To test this hypothesis, we studied the effects of mild to moderate cold stress on limb length and bone microarchitecture in young, rapidly growing mice as a model for humans. Male C57Bl/6J mice were group housed from 4 wks of age to 6.5 or 12.5 wks of age at 26° C (warm), 22° C (standard vivarium temperature, a mild cold stress for mice), or 18° C (moderate cold stress), with access to food and water ad libitum (N=4/group). The results showed no differences in body mass, limb length, or food intake among groups. Trabecular bone in the distal femur and proximal tibia showed no significant differences in bone volume fraction, trabecular number or thickness. Cortical bone from the midshaft femur and tibia showed no significant differences in cross-sectional geometry or bone area fraction. Overall, our results indicate that mild to moderate cold stress does not alter cortical or trabecular microarchitecture in wildtype mice. These data do not support our hypothesis, but are consistent with recent studies suggest brown fat thermogenesis protects against cold-induced bone loss. Ongoing analyses are measuring brown fat Ucp1 expression across temperature groups to determine whether brown fat thermogenesis contributed to these patterns.

**Placenta-specific protein 1 (PLAC1): An ancient and crucial element in placental health and development and a potential therapeutic target in uterine and ovarian cancers**

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Placenta-specific protein 1 (PLAC1) is a small, secreted protein normally expressed only in trophoblasts. The primary function of PLAC1 is to promote placental invasion of the uterine epithelium and anchoring to the stroma. We have shown that PLAC1 is also expressed in adenocarcinomas of the uterus and ovaries where it is recruited by the cancer cells to enhance tumor growth and invasiveness.

The important role of PLAC1 in placental health and development as well as in the growth and invasiveness of uterine and ovarian cancer cells has led us to characterize its evolutionary history. We have assembled PLAC1 sequence in twenty five placental mammal species representing nine crown orders of the Mammalia. In addition, we have carried out exhaustive searches of three marsupial and one monotreme genomes. Our phylogenetic analysis indicates that PLAC1 is unique to placental mammals, that it emerged at or very near the divergence of the eutheria from the metatheria and that it has been under strong purifying selection since its emergence.

This phylogenetic history, coupled with functional genomics data, suggest that this protein is a crucial element in the establishment and maintenance of the placenta. Its expression in uterine and ovarian tumors and cultured cells further suggests that it is recruited by these cells to perform the same functions in cancer cells. This makes PLAC1 the only known onco-placental protein and a potential marker/therapeutic target in both gestational disorders such as preeclampsia and pre-term birth and in uterine and ovarian cancer.

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### Famine and Frailty: Crisis Mortality and Stature in Medieval London

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During the 12<sup>th</sup> - 16<sup>th</sup> centuries A. D., London was one of Europe's largest urban centers and suffered from frequent cereal shortages that were capable of instigating massive famine-related mortality. To examine biological susceptibility to famine mortality and to test the hypothesis that early-life developmental stress increases risks of mortality from famine during adulthood, this study examines skeletal material from the St. Mary Spital cemetery (SRP, c. 1120-1540) from London. SRP includes both single and multiple interments, and the dating and demographic profiles of the latter suggest they were used during famines. We selected 357 adults from single interments and 191 adults from multiple interments to examine the relationship between stature and risk of death under conditions of both normal and famine mortality. Ages were estimated using transition analysis, and tibia length, as a proxy for stature, was modeled as a covariate affecting the Gompertz hazard function. Stature was found to be negatively associated with risk of mortality in both the normal mortality and famine samples. These results are consistent with previous findings from medieval London that short stature was associated with increased risks of mortality during the Black Death, and suggest that short stature is a risk factor or a marker for some other underlying risk factor under various mortality conditions. These results further demonstrate the worth of hazard modeling within bioarchaeological research, and can lend paleodemographic support to scholars' understanding of famine mortality patterns more generally.

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### Using Ancient DNA to Discover the True Domestication Origins of South American Camelids

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Our research intends to provide a better understanding of the origins of domestication of the common alpaca (*Vicugna pacos*). Previous studies have offered contradictory explanations for determining this species' domestication history. Two possible wild organisms, the vicuña and the guanaco, are thought to be the ancestral species that led to modern alpacas and llamas. However, the precise relationship between the

wild and the domesticated species is still unclear. The most recent molecular genetics analyses, propose that the alpaca is a domesticated vicuña, hence its scientific name. The results, however, are not clear as to which species is the wild ancestor because of recent bidirectional hybridization among llamas and alpacas. We approached this discrepancy using ancient DNA from fossil South American camelids, along with modern samples from domesticated alpacas and llamas and wild vicuñas and guanacos. We hypothesize that by looking at specimens as old as 5,000 years ago, before the Spanish conquest, which is the presumed cause of the hybridization event, we could identify molecularly the true wild ancestor to alpacas. Ancient mitochondrial DNA sequences were analyzed to determine the phylogenetic relationships among these four species. Molecular analyses of ancient DNA allowed the testing of phylogenetic models which lead to inferences about gene flow and genetic differentiation among the species. Our ancient molecular data strongly suggests that the alpaca is a domesticated guanaco, as opposed to previous research that places the vicuña as the wild ancestor.

### Facial shape in trigonocephaly: a metric and geometric morphometric assessment

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Archaeologically, individuals with prematurely fused sutures are plentiful, excepting those with trigonocephaly. When coupled with the fact that clinical descriptions are limited to late fetal-early postnatal stages, this leaves knowledge of later-stage growth changes unknown. We hypothesize that shape changes seen in the face of trigonocephalics are driven by anterior brain malformations and that with growth this results in a cascading series of morphological changes in the face that spare the nasal capsule.

A trigonocephalic skull deriving from Santa Rosa Island (CA-SRI-24; 1500-1650 AD) and housed at UC Berkeley (PHMA) was compared to 35 skulls from the Institute for Craniofacial Study, UOP. Developmental ages of 8.0 years and 6.0-8.0 years±24 months were assessed for the trigonocephalic and normal skulls, respectively. Landmark data comprise 93 points collected from normal skulls with a Microscribe 3D digitizer and from a CT scan of the trigonocephalic using Amira 5.5. Facial shape was explored using Principal Components Analysis on Procrustes-aligned shape variables.

Metric and geometric morphometric analyses confirm that the nasal capsule is essentially

normal. Alternatively, significant narrowing and wedging of the frontal result in increased frontal and orbital heights, demonstrating compensatory changes in the anterior cranial fossa and lateral face, respectively. Upper facial elongation is associated with an increased breadth of the lower face, while lower face length shows only slight involvement. Causative factors resulting in trigonocephaly are obscure. Consideration of endocranial shape, along with the results above, supports suggestions that brain malformations may underlie the complex trigonocephalic phenotype.

### Maintaining and reinforcing commitment in the pair-bonded Bolivian gray titi monkey, *Callicebus donacophilus*

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Titi monkeys, *Callicebus*, are the only primates strictly conforming to the standard monogamous profile, being monomorphic and territorial with a high level of paternal investment. Tightly bonded male and female pairs are known to experience strong physiological and behavioral responses to separation. Titi pairs maintain and reinforce these bonds through a suite of affiliative behaviors (e.g. grooming) and conspicuous vocal and visual displays (e.g. duetting and tail-twinning). Little is known, however, of the relative contributions of the male and female to pair bond maintenance and whether investment varies with the reproductive cycle. Pair bond maintenance behavior (grooming, approach/follow interactions, contact and tail-twinning) was recorded for 4 habituated groups of wild Bolivian gray titi monkeys at Yvaga Guazu, Santa Cruz, Bolivia from February 2010 to December 2011. Pair bond maintenance behavior was found to be significantly higher and the male invested more in the relationship after the birth of an infant and the duration of its dependency. Affiliative behavior declined significantly during the mating season, March through May, and male and female investment was reciprocal with a marginally greater investment by the female.

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### Habitat quality and behavioral ecology of the Northern sportive lemur (*Lepilemur septentrionalis*)

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Comparisons of the behavioral ecology of primates living in different habitat qualities are critical for evaluating a species' diet and behavioral plasticity. Understanding this intraspecific variation is fundamental to the development of conservation strategies for primates threatened with habitat loss. From June to July 2013 we conducted a study of four Northern sportive lemurs (*Lepilemur septentrionalis*) living in different forest fragments in Montagne des Français, Madagascar. We investigated habitat use, feeding ecology, and ranging behavior to describe individual activity budget and diets, and to relate individual differences in these behaviors to variation in habitat quality. Variations in number of anthropogenic disturbance types, tree density, species diversity, total basal area, and presence of an invasive species, *Lantana camara*, were indicative of the degree of habitat degradation. The percentage of time feeding was only slightly higher for individuals living in more degraded habitat than those in less degraded habitat. There was no difference in the variety of food items consumed, but the percentage of time consuming different items varied. Individuals in more degraded habitat spent a lower percentage of time consuming leaves and a considerably higher percentage of time consuming fruit. Furthermore, the home range size was larger for individuals in the more degraded habitat. These preliminary data suggest that *L. septentrionalis* in more degraded habitats altered their behavior by incorporating more fruit into their diet and increasing their home range size. These results are encouraging, as they indicate that *L. septentrionalis* is able to live in a variety of habitat types.

*Our research was supported by the Primate Action Fund of Conservation International.*

### Why have tarsiers jumped between so many branches of the primate tree?

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The phylogenetic position of tarsiers within the order Primates has been contentious ever since they were alternatively classified within the

Prosimii as a sister-taxon to a Lemnidae/Lorisidae clade, or within the Haplorrhini, as a sister-taxon to Anthropoidea. While most researchers today would classify them as haplorrhines, inferring their phylogenetic placement using molecular data over the last nearly 40 years has been fraught with difficulties. Early immunological studies using a variety of techniques were ambiguous in their results. Chromosomal analyses of tarsiers are extremely difficult because of the dramatic reorganization of their genome, as well as high chromosome number. Amino acid sequencing studies barely support the haplorrhine hypothesis, and have suffered from very poor taxonomic sampling. Nuclear DNA sequencing has provided underwhelming evidence for the haplorrhine hypothesis as well. Mitochondrial sequencing studies, including those utilizing the whole mtDNA genome, have failed to convincingly place tarsiers even *within* the order Primates. Only recently has research that incorporates high taxonomic density, along with new analytical techniques, firmly placed the tarsiers within Haplorrhini. The types and quantities of molecular data, the methods used to analyze those data, and especially the level of taxon-sampling that provides the most robust phylogenetic signals will be discussed. Lessons drawn from investigating tarsiers provide us with crucial insights for inferring the phylogeny of other hard-to-place taxa.

### Potential Influences on Rib Osteon Area

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Secondary osteons are often assessed in histomorphometric analyses, but the forces acting on osteon size are as yet poorly understood. This study examines the relationships of sex, age, cortical area, and cortical porosity on osteon area in the ribs, also exploring differences between the pleural and cutaneous cortices. The sample consisted of 49 mid-shaft 6<sup>th</sup> ribs, from individuals 6–92 years of age. Tested variables included percent absolute cortical area (%Ct.Ar), percent cortical porosity (%Po.Ar), and average osteon area (On.Ar), which were collected or calculated for each of the cutaneous and pleural cortices and then pooled for the total rib for each individual.

A *t*-test revealed no significant differences between sexes; samples were pooled for all further analyses. Significant correlations were found between age and both %Ct.Ar and %Po.Ar. As such, multiple linear regression tested the effect of %Ct.Ar and %Po.Ar on On.Ar, with age treated as a covariate. Results indicated that %Ct.Ar is the only variable in complete ribs to have a significant relationship with On.Ar ( $p=0.024$ ). On the cutaneous cortex, both %Ct.Ar and age ( $p=0.014$  and  $p=-0.025$ ,

respectively) were significant, while on the pleural cortex, On.Ar was found to have no significant relationship with any of the variables.

These results suggest that the amount of cortical area available for remodeling influences the size of osteons. While %Po.Ar was not statistically significant, trends indicate that as intracortical porosity increases, On.Ar decreases, further supporting this suggestion. Differences between the cortices are attributed to their known differential rates of bone loss.

### Mummified baboons clarify ancient Red Sea trade routes

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The tandem origins of maritime trade and international diplomacy have roots in the Red Sea region. Graphic and epigraphic accounts of this trade often provide specific place names, or toponyms, with unambiguous geographic locations. Yet the location of one crucial polity, Punt (or *Pwnt*), remains uncertain. Punt was a major emporium of gold, electrum, and biological materials such as myrrh, ebony, ivory, short-horned cattle, leopards, and baboons (*Papio hamadryas*). The importance of these materials is reflected in the 1200-year duration of trade between Ancient Egypt and Punt (Vth-XXth Dynasties; ca. 2458-1163 BC). The recovery of mummified baboons from several New Kingdom tombs, which was a period of thriving trade with Punt, raises the possibility of using stable isotope analysis to source their provenience. Here we report the oxygen and strontium stable isotope composition of two *P. hamadryas* mummies from XXth Dynasty tombs. We also analyzed the hair and bone of modern baboons in 106 habitats spanning five hypothesized locations of Punt: (1) Eritrea-Ethiopia; (2) Mozambique; (3) Somalia; (4) western Uganda; and, (5) Yemen. Isoscapes based on kriging interpolation of hair keratin  $\delta^{18}\text{O}$  values and bioapatite  $^{86}\text{Sr}/^{88}\text{Sr}$  ratios were produced and an index of similarity was calculated based on the geometric mean of the two kriged maps. Our results reveal a high likelihood match with eastern Somalia and the Eritrea-Ethiopia corridor, suggesting that this region was the source of *Papio hamadryas* exported to Ancient Egypt.

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## AAPA Abstracts

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**Allostatic load varies by genotype, age, sex, and social factors in American Samoans**

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Cumulative wear-and-tear on the body through maintenance of homeostasis is deemed an allostatic load (AL). Individuals with high AL are at risk for multiple noncommunicable diseases, morbidity, and earlier senescence and mortality. Using alleles at the apolipoproteins (apoe) E and H, angiotensin converting enzyme (ACE), and atrial natriuretic peptide (ANP) loci, we determined genetic associations with AL in a sample of 273 American Samoans. We also examined relationships of AL with age, sex, and social variables (annual income, number of household members, education level). We used three combinations of biomarkers to assess AL: Model 1: 6 established secondary mediators of allostasis and insulin; Model 2: Model 1 plus triceps and subscapular skinfolds, BMI, RFPI, and waist/hip ratio; Model 3: Model 1 plus triglycerides, fasting serum glucose and LDL cholesterol. Biomarker values in the highest quartile of risk were assigned a value of 1, others 0. Women had greater AL, as did individuals carrying the apo E 3,3 or 3,4 or the ACE I-I genotype. Specifically, women and men age 55 and over with the apo 2,3 genotype and individuals under age 55 with ACE I-D polymorphism had lower AL than their counterparts. Associations with education were not clear-cut, but in general those with higher education had lower AL. Our results are the first to confirm a significant influence of genotypes on AL among a Polynesian sample. Furthermore, it is the first to show that genetic influences on AL may be modulated by social factors within populations.

**Preliminary report on the use of GPS/GSM tracking devices to estimate the vervet monkey (*Chlorocebus aethiops sabaeus*) population on the island of St. Kitts**

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Ethnographic data collected since 2010 show that Kittitian people believe the vervet monkey population outnumbers the human population (of ~50,000 individuals on 68mi<sup>2</sup>). Scientific estimates of the St. Kitts vervet monkey population have gradually increased, from 1,500 in 1965 to 5,700 in 1972 to 7,000 in 1974 to 30,000 in 1980, with the exception of the most recent (2010) estimate of 15,000, which sparked local outrage. Since there are no habituated free-

ranging St. Kitts vervet monkeys, this study utilizes newly available GPS/GSM technology to conduct the most systematic estimate of the St. Kitts vervet monkey population to date. In July 2014, ultra-light (220g) Tellus brand GPS/GSM tracking devices were placed on adult males from two distinct groups on the southeast peninsula. The goal of this work is to establish the size and geographic range of troops in four distinct habitats in St. Kitts (southeast peninsula, village, farm, and forest). The assumptions of this estimate are that the monkeys live everywhere on the island, troop sizes and ranges are consistent within habitats, and, due to the territorial nature of vervets, a smaller range will indicate more troops in the habitat and vice versa. Habitat-specific troop sizes will be documented visually with hides placed at traps. This technology is especially useful, as GPS coordinates are sent in real-time via the GSM network and can be viewed immediately online. Thus far, 63 days of data have been collected. The battery life of these devices is nine months (when collecting 32 waypoints per day).

Ross University School of Veterinary Medicine, St. Kitts IACUC #14-6-032. This project was generously funded by the Christophe Harbour Foundation.

**Don't judge a female by her swelling: variability in the timing of ovulation in relation to sexual swelling patterns in wild female bonobos (*Pan paniscus*)**

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Variability in the timing of ovulation in relation to female sexual swelling patterns differs across the primate order, impacting a male's ability to pinpoint ovulation and thereby affecting male mating strategies. We examined how endocrine parameters that are indicative of ovulation are associated with sexual swellings in wild female bonobos (*Pan paniscus*) and the temporal relation between the maximum swelling phase (MSP) and ovulation. Data were collected at the Luikotale field site, Democratic Republic of Congo, spanning 36 months from 2010 to 2013. Observational data on female sexual swellings (n=14 females) were used to characterise female swelling cycles. Furthermore, we combined urinary oestrone and pregnanediol analysis using LC-MS to determine the timing of ovulation in 34 cycles from a subset of 9 females. Duration of the MSP was highly variable, lasting from 2 to 30 days. Timing of ovulation varied considerably in relation to the onset of the MSP, resulting in a low probability of ovulation occurring on any particular day of a female's MSP. Our results suggest that sexual swellings in wild female bonobos are not reliable indicators of ovulation, and that the temporal inflation and variability of these visual sexual signals in relation to

ovulation may constrain mate guarding efforts by males.

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**A (w)hole new idea: Using nutrient foramen location to identify relative growth and the center of ossification in juvenile tibiae**

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Tibiae growth begins with ossification in the center of the cartilaginous diaphysis and proceeds toward the proximal and distal ends. Growth reportedly occurs 57% proximally and 43% distally. It is proposed that the nutrient foramen can be used to closely examine these growth rates. Also, radiographs can be useful for identifying the center of ossification and its relationship with the foramen.

Diaphyseal lengths, and dimensions from the nutrient foramen to proximal and distal ends were measured in 363 juvenile tibiae from five samples. Two are of British medieval origin from Poulton (n=171), and Gloucester (n=42). The others derive from Romano-British Poundbury (n=41), English civil war Abingdon (n=31) and Georgian/Victorian Spitalfields (n=78).

Spitalfields individuals are of known sex and age, Poulton juveniles were seriated using dental age, and all others were seriated by diaphyseal bone length as dentitions were not available. To investigate the center of ossification, a sub-sample from Gloucester (n=30) was x-rayed. Metal wire was placed in the nutrient canal and a second metal piece marked the foramen. Measurements were then taken from the canal to the proximal and distal ends.

Greater absolute distal growth occurred. Unexpectedly, relative proximal and distal growth remained constant and the greater distal growth appears to be antenatal. Throughout the age range (neonate to post-pubescent) the mean nutrient foramen position remains at 69% of the total length from the distal end. Measurements from the assumed ossification center have a mean of 43.10% proximally and 56.90% distally, exactly opposite those of previously expected growth rates.

**Early-life growth deficits and adulthood mortality: developmental stress effects in KhoeSan foragers from southern Africa's Later Stone Age**

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Resilience and adaptation in past populations are increasingly studied through the lens of childhood stress. Neural canal size (NC) in the thoracic and lumbar spine shows potential as a marker of stress because it reaches adult size relatively early in development and is therefore less amenable to catch-up growth.

Research has linked smaller canals to earlier adult mortality, but confounding by socioeconomic factors is a potential concern. This study tests the hypothesis that a smaller neural canal is associated with lower adulthood survival in Later Stone Age KhoeSan foragers, a population with little evidence of social inequality.

Anteroposterior (AP) and mediolateral (ML) diameters were measured at T1, T6, L1, and L5 ( $n=143$ ). Preservation varied, so missing values were imputed in 5 iterative datasets, giving a final  $n=105$  ( $F=49$ ;  $M=56$ ). Femur length and head diameter served as proxies for body size. Individuals were categorized as “young” ( $<35$  years) or “mature” ( $35 \leq$  years) based on conventional indicators. Logistic regression was used to test the hypothesis.

An increase in ML equal to 1 standard deviation was associated with, on average, 60% greater odds of surviving to mature adulthood ( $p<0.05$ ), while AP diameter showed no effect. The effect was strong in females, but weak in males. Body size was not a significant confounder.

Although confounding by environmental stressors cannot be ruled out, these results suggest that childhood outcomes and adulthood survival are linked even when social stratification is minimal. Early-life growth effects may be a long-standing feature of human life history.

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#### **A test of bone remodeling as a response to incurred loads**

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Bone remodeling has been proposed as a mechanism to repair microdamage and, as a consequence, it is expected to be higher in bones that incur larger or more loading events. Handedness in humans, in which one upper limb is favored relative to the other, is a natural experiment of different loading environment while controlling for all other factors that can

influence remodeling (age, diet, sex, etc.). In this study, we test for correlations between the asymmetry of bone cross-sectional geometry and bone remodeling in the human second metacarpal (MC2). We use right and left cross sections from two archaeological samples (Eurocanadians = 59, Inuit = 23, total=82) and measured total and cortical areas, second moment areas ( $I_{min}$ ,  $I_{max}$ ,  $I_{ml}$ ,  $I_{lp}$ ) and polar moment of inertia (J). Osteon population density (OPD) was measured on the medial, anterior, lateral and posterior quadrants. We expected that larger cross sections would be characterized by greater remodeling. However, we found that right-left % differences of all macroscopic variables were negatively correlated with OPD. Closer inspection of the sample revealed that the correlation was observed only on the medial quadrant and only for the Inuit subset of our sample. The Inuit MC2s are characterized by relatively thin cortex, particularly on the medial side. We conclude that remodeling does not directly reflect external loading history, but may, instead, be differentially needed only in areas that are relatively weaker or in areas that are highly strained due to the proximity of muscle insertions.

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#### **From Anthropological Genetics to Discovery of Genes for Complex Diseases in Human Populations: The Transdisciplinary Impact of Professor Michael H. Crawford**

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We are delighted to be part of this symposium in honor of our beloved teacher, mentor, and colleague Professor Michael H. Crawford. Several of us are either Prof. Crawford's direct students or academic relatives who have been strongly influenced by his anthropological genetics thoughts and teachings in molding our academic and professional careers, particularly in the fields of population genetics, statistical genetics, and genetic epidemiology. As a tribute to his academic/professional excellence and impact on his students and colleagues, here, we report findings from genetic studies of common complex diseases in the Mexican American (MA) population, an admixed (with substantial

Amerindian ancestry) and the fastest-growing minority population in the U.S. Since 1991, we have examined the genetics of complex diseases including type 2 diabetes, cardiovascular disease, obesity, and other cardio-metabolic phenotypes, using data from two large MA pedigree-based studies in San Antonio, Texas, named San Antonio Family Heart Study and San Antonio Family Diabetes/Gallbladder Study, together referred to as San Antonio MA Family Studies (SAMAFS). Over the years, our findings have ranged from simple heritability estimates and genetic correlations to mapping of susceptibility genes using genome-wide linkage/association approaches and identification of potential rare functional variants using whole genome sequencing data. We will summarize some of the findings from SAMAFS investigations and from a study of child relatives of SAMAFS participants. The ultimate goal of our findings is to discover novel causal genes/pathways that will help cure or prevent the complex metabolic diseases in Mexican Americans and in global populations.

#### **Ecological niche selectivity in *Australopithecus anamensis***

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Kanapoi (Kenya) is the type-site for *Australopithecus anamensis*, the first indisputably bipedal hominin species. In this study, 350 mammal fossils ( $> 5$ cm) from the published Kanapoi collections are described and compared to a smaller assemblage ( $n=30$ ) from the Mursi Formation (Ethiopia). These geographically close assemblages ( $< 300$  km apart) both have estimated ages of over 4 million years. The majority of the fossils attributed to *A. anamensis* have been found at Kanapoi, but no hominin remain have been found so far at the Mursi Formation sites. This research aims to explain this difference in hominin abundance. Analyses reveal that there were important taphonomic and paleoecological differences between the two assemblages despite the fact that their faunas were found to be similar in composition. The significant difference between the polishing levels of the remains ( $p = 0.02$ ) suggests that the paleoenvironment of the Mursi Formation was more closely associated with water. In addition, the more evenly distributed weathering levels in the Kanapoi fossils ( $p<0.001$ ) indicate that the bones in the assemblage accumulated on the surface over an extended period of time prior to burial, which further suggest drier local conditions than at the Mursi Formation. This new evidence provides key information for our understanding of ecological niche selectivity during the time of emergence of the genus *Australopithecus*.

## AAPA Abstracts

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### Scapular geometry and forelimb use in four sympatric cercopithecids

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Numerous comparative studies have identified scapular features that sort primates into different locomotor groups. Among the most diagnostic traits are those that distinguish primates that habitually engage in forelimb suspension from more quadrupedal taxa. Such discriminating features include overall scapular shape, supra- and infra-spinous fossa size, glenoid geometry, and orientation of the scapular spine.

We collected forelimb-use data on four cercopithecoid species in the Ivory Coast's Tai Forest and determined there were striking differences in the extent these monkeys elevated and abducted their forelimbs during foraging. *Procolobus badius* reached above its head most frequently while *Cercocebus atys* did so least often. *Colobus polykomos* and *Cercopithecus diana* were intermediate in these behaviors. Here we test the hypothesis that scapular features associated with forelimb suspension in other primates co-vary with the degree of forelimb elevation/abduction used by Tai monkeys during foraging. We took eleven measurements on scapulae (N=30) of each species and compared sample means and functional indices using general linear models ( $\alpha=0.05$ ).

Our analyses indicate that relative scapular shape ( $p<0.01$ ), supra-spinous fossa size ( $p<0.01$ ), glenoid depth ( $p<0.01$ ), glenoid shape ( $p<0.01$ ), and scapular spine angle ( $p<0.01$ ) discriminate taxa in the manner predicted. Means for bar-glenoid angle ( $p=0.23$ ) and acromial projection ( $p=0.10$ ) trend in the predicted direction but lack statistical significance. We conclude that scapular features associated with brachiation and vertical climbing can also be used to infer patterns of forelimb use not involved in locomotion, such as those occurring during food retrieval. This insight can enable more informed reconstructions of fossil behavior.

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### Body mass estimation in paleoanthropological and bioarchaeological contexts: validation with a known body mass modern human sample

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The utilization of body mass estimation equations in paleoanthropological and bioarchaeological contexts is essential in reconstructing the life-ways of past populations and individuals. Validation of body mass estimation is limited, as few skeletal collections have recorded body mass of accessioned skeletons. This study aims to validate the estimation of body mass in anatomically modern humans, and elucidate the paleoanthropological implications. Two methods commonly used for osteometric estimation of body mass are compared here: femoral head diameter and bi-iliac breadth/stature measures.

This study compares these commonly used methods for body mass estimation in a documented sample drawn from William M. Bass Donated Skeletal Collection (n=388) consisting of 154 females and 233 males. All individuals in the sample are of known forensic body mass which range from 36.3kg to 190.5kg.

Results indicate that the methods of body mass estimation from osteometric distances compare well throughout the range of body masses in the sample but osteometric dimensions are poor predictors of forensic body mass in individuals whose body masses are considered underweight and obese ( $p>0.05$ ).

Although there is reliability in body mass estimates for the middle range of body mass, there are implications for individuals who are variable in form such as obese and underweight anatomically modern humans, and non-human hominids. This study brings into question the reliability of body mass estimates of these individuals. Further investigation of known body mass priors are needed to strengthen anthropological interpretation of past forms and life-ways.

### The "obstetric dilemma" hypothesis unraveled

HOLLY DUNSWORTH. Sociology & Anthropology, University of Rhode Island.

Difficult childbirth and helpless infants have long factored into reconstructions of human evolutionary history, and within a context of human uniqueness. Thus, it has fallen under paleoanthropology and archaeology's purview to determine when and how these two phenomena developed. For several decades we have mainly worked under one hypothesis, the "obstetric dilemma" (OD), which holds that antagonistic selection for hominin encephalization and bipedalism resulted in difficult and early childbirth. However, current fossil, anatomical,

behavioral, archaeological, historical, cultural, clinical, demographic, epidemiological, primatological, life history, and metabolic evidence demands that we update our view of human childbirth and neonatal development. It also suggests that much of the relevant data that the fossil and archaeological records tend to provide, namely brain sizes and pelvic morphologies, may not be particularly useful for elucidating the evolutionary processes that resulted in present childbirth difficulty and timing. Given the evidence, here we ask how to test the OD, now or in the future. We also consider alternative explanations for the evolution of difficult human childbirth, its timing, and the developmental state of human neonates. It is increasingly challenging to find support for the OD, let alone to test it and alternative hypotheses, but there are promising possibilities.

### New estimates for stature in the Roonka Flat skeletal sample using the Revised Fully Technique

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The Roonka Flat skeletal sample from South Australia encompasses the remains of approximately 200 Aboriginals buried throughout the Holocene (between 8,000 – 200 years ago). A subset of ten individuals from this sample is complete enough for the calculation of Revised Fully statures (following Raxter et al., 2006). The data from this subset is used to calculate ratios for the maximum lengths of the humerus, femur, and tibia to overall stature. These ratios are used to estimate statures for the remainder of the Roonka skeletal sample. The results indicate that both males and females in the population sampled at Roonka are notably shorter than previous estimates, with slightly longer humeral and femoral ratios and a slightly shorter tibial ratio to stature than those reported in an earlier project. These results echo previous work in finding that the tibiae of Australian Aboriginals are exceptionally long when compared to non-Australian samples. The use of anatomical methods and element data from within the assemblage to estimate stature ensures that the techniques employed are both regionally and temporally appropriate for this sample.

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**Coding and Quantifying Traits on the Skull Used in Ancestry Estimations in Forensic Anthropology: Results from a Midwestern Amerindian Cemetery**

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Morphoscopic traits used in ancestry estimations are described in forensic anthropology textbooks, but are not often quantified. We sought to augment the literature by quantifying traits among pre-Columbian Midwestern crania (Males = 56; Females = 46) from the Schild site (AD 700-1250) in west-central Illinois. Our goal was to understand the usefulness of morphoscopic traits in correctly estimating the ancestry of isolated pre-Columbian skulls.

We systematically coded twenty-two traits of the vault, nose, malar, palate and mandible. We found that cranial portions of males and females frequently had a mix of traits from all four ancestral groups. This mixture was demonstrated by a low frequency of Schild males and females displaying all of the traits typical for American Indians. However, some traits at Schild had frequencies that exceeded 60% among males and females such as sagittal keeling, straight palatine suture, tented nasal root contour, posterior zygomatic tubercle, and forward facing nasal processes. From the trait frequencies, expected probabilities for correctly classifying or misclassifying individuals from Schild were calculated. The use of multiple traits from facial portions performed better than traits from the cranial vault.

We conclude that isolated crania from pre-Columbian sites are highly variable and run the risk for misclassification. Further research is needed to understand population variation across the region and throughout time. An archaeologist should assist in all outdoor recoveries of skeletal remains and molecular analyses may be needed to determine an individual's ancestry for narrowing the focus of missing person's investigations.

**Worldwide genetic variation and kinship systems: An anthropological perspective on human origins research**

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In the study of modern human origins and dispersals, kinship systems and mating patterns play an important strategic role connecting patterns of genetic variation with sociocultural and linguistic systems. While multiple studies have shown that ancient kinship systems and mating patterns likely contributed to the

observable regional and global clines of genetic variation, no comprehensive study of worldwide kinship-systemic variation as it relates to genetic variation exists to date.

In a pioneering effort (Dziebel 2007), I assessed global kinship system variation on the basis of a database of 2500 kinship systems ([www.kinshipstudies.org](http://www.kinshipstudies.org)) using methodologies of social anthropology, populational and historical linguistics. Some segments of kinship terminological variation (sibling sets, cross-generational equations, etc.) yield to a global phylogenetic analysis and their unilinear evolution was tested against regional datasets (Na-Dene, Austronesian, Niger-Congo, etc.)

Strong agreement has been observed between the worldwide patterns of genetic and kinship-systemic variation. African and Amerindian patterns of kinship variation are the most divergent from each other, with African kinship systems clustering with European and Amerindian with East Asian, Papuan and Australian systems. Consistent with autosomal and haploid genetic evidence, Amerindian kinship structures indicate underlying highly structured populations, long-term low population size and density and high levels of genetic drift. Alternatively, extensive genetic differentiation in Sub-Saharan Africa corresponds to complex marital networks enabling long-range gene flow and a simplified kinship terminological profile. However, the inherent evolutionary dynamic responsible for the worldwide patterns of kinship-systemic variation is not compatible with a simple Serial-Bottleneck-Out-of-Africa scenario of modern human origins.

**A Multidisciplinary Approach to Analyzing Sex and Gender in the Ancient World using aDNA and Stable Isotope Analysis: A Pilot Study from the Dakhleh Oasis, Egypt**

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The identification of biological sex from ancient human remains can reveal nuanced differences in the life experiences of males and females in the past. In many circumstances, however, the determination of sex is difficult, inaccurate, or even impossible. Here we propose a novel approach to examining sex of human remains using a portable DNA probe in combination with isotopic analysis. Ancient DNA (aDNA) was used to identify males and females buried in the Kellis 2 cemetery (50-450 AD) in the Dakhleh Oasis, Egypt. The investigation of 13 individuals combined stable isotopic analysis of nitrogen, carbon, and oxygen from bone collagen and apatite with the analysis of aDNA to reveal

patterns between sex and diet, health, and migration. The results of aDNA analysis demonstrate the feasibility of the new DNA detection method by testing sex determination in a context where morphological traits provided less accurate assessment of individual sex. Isotopic analysis indicates a fairly standardized diet of C3 plants and some evidence of differentiation in protein intake and health status in relation to sex. In addition, stable oxygen isotopes reveal no evidence of migration among this small sample that would be linked to sex differences. These findings not only enhance understandings of the lives of the inhabitants of Kellis in relation to sex and gender, but the multidisciplinary approach may be employed in the future to identify sex of fragmentary, comingled, or sub-adult human remains; thereby shedding light on a data set that, until now, has been largely impenetrable.

**Liang Bua Cave (Flores) humans (aka "Homo floresiensis") exhibit individual variation and temporal change, not uniformity and stasis**

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Liang Bua Cave (LBC) reportedly yielded 15 homogeneous individuals. "Homo floresiensis" was founded on LB1 plus LB2 P<sub>3</sub> (Brown et al. 2004). Morwood et al. (2005) described LB4 (child's radius and tibia), LB6 (mandible, incisor, scapula, radius, ulna, metatarsal, 8 phalanges), LB7 (phalanx), and LB9 (femur fragment). Morwood and Jungers (2009) listed 97 bones: LB1 (n=62), LB6 (16), LB11 (3), LB2, 4, 5, 8, 15 (2 each), LB3, 9, 10, 12, 13, 14 (1 each). Our group (Jacob 2005) independently inventoried LBC bones.

The adult human skeleton comprises ~206 bones. Were all 15 LBC individuals complete they would total ~3090 bones. All LBC bones enumerated now sum <120 (given overlap and incompleteness), <4% of maximum possible.

Not all known bones are figured and described. LB1 comprises >half the total (including the only skull, humerus, femurs); LB6 (16 bones including another mandible and the only described scapular fragment) comprises about 10% to 15%; LB11 (3 fragments) another 2 to 3%; LB2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14 and 15 each comprise 1% to 2% of the total described. Individual to individual element overlap is very low, rendering uniformity moot in much other than approximate size, which appears exaggerated downward (De Klerk 2012).



Contrasted with LB6 (157 mm complete, distorted) radius at ~15.7-18.7 Ka, LB3 partial radius (~210 mm estimated length) at ~74 Ka is within modern human range, suggesting stature 1500 to 1600 mm, consistent with size reduction through time (Perry et al. 2014) in LBC humans.

**Dominance in dental morphological traits: Implications for biological distance studies**

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Hispanic New Mexicans are known to primarily descend from Europeans and Native Americans, with only a very small African component to their ancestry. South Florida Hispanics are thought to be primarily of Cuban descent, with more African and European ancestry than Native American. However, previous research has shown that dental morphology in Hispanics from New Mexico and South Florida are not discernably different. Dominance in dental characteristics associated with Native American ancestry provides one potential explanation for this phenomenon. To test this explanation, we compared frequencies of 48 dental morphological traits in Hispanics from California, Florida, New Mexico and New York (n=454) to expected values computed from frequencies of ancestry-informative markers in ancestral populations (Native Americans, Western Europeans, and West Africans; n=917) and published admixture estimates from genetic data.

Overall, trait observations deviated significantly from expected frequencies in every group (p<0.001). Trait expressions are higher than expected in the Florida, New Mexico, and New York samples. The most affected traits include maxillary canine distal ridge, second molar Carabelli's trait, mandibular first molar anterior fovea, and second molar protostylid at higher than expected frequencies, and mandibular third premolar lingual cusp complexity and first molar Y-groove pattern at lower than expected frequencies. These traits are commonly used in biological distance studies, and several are used in forensic estimation of ancestry. The bias introduced to such studies, which assume equal and additive inheritance of dental traits likely causes an over-estimation of Native American affinity in admixed groups.

**Implications of the apportionment of human genetic diversity for the apportionment of human phenotypic diversity**

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Two facts about human genetic variation have often informed claims about the genetic basis of human phenotypic diversity. The first result is that at most loci, apportionments of human genetic diversity find that worldwide populations are genetically similar. The second is that when multiple loci are examined, it is possible to distinguish people with ancestry from different geographical regions. What do these facts imply about human differences on complex traits—including anthropometric traits and medical outcomes? One possibility is that such traits follow the pattern of similarity observed at individual loci. Alternatively, because they have a multilocus genetic architecture, such traits might aggregate information about population membership from many loci, generating larger group differences. To address the question, we combine single-locus diversity partitioning, multilocus classification, and phenotypic diversity partitioning by extending a well-known classification model of A.W.F. Edwards to include a selectively neutral quantitative trait. Under the extended model, we show, consistent with previous work in quantitative genetics, that regardless of how many genetic loci influence the trait, one neutral trait is approximately as informative about ancestry as a single genetic locus. The results support the relevance of single-locus genetic diversity partitioning for predictions about phenotypic diversity—for typical neutral traits, heritable phenotypic diversity mirrors the similarity of human populations observed at individual genetic loci.

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**Bent out of shape: Cross-sectional geometric properties of the primate zygomatic arch**

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Forces associated with chewing subject the cranium to varying loads (e.g., bending and torsion), depending on the material properties of the food being consumed. As such, cross-sectional geometric properties (e.g., cortical area (CA) and cross-sectional shape (CSS)) are expected to reflect the magnitude and types of loads experienced. As a site of high chewing loads, the zygomatic arch is expected to respond to increased masticatory forces; however, it is unclear whether this response manifests as changes in the internal cortical bone distribution of the arch and/or arch CSS. Furthermore, strain is highest anteriorly and decreases posteriorly along the arch, but it is unclear whether the morphology reflects this variation. Here, these discrepancies are addressed through a comparative analysis of zygomatic arch CA and CSS.

Data on CA and CSS were collected from microCT scans of zygomatic arches from 8 species of haplorhine primates (n=57). Primates were separated into two dietary groups (resistant or non-resistant consumers) according to their dietary material properties. CA and CSS values were compared between dietary groups at several points along the zygomatic arch.

Pairwise comparisons of zygomatic arch CA measures between closely related taxa of differing dietary group revealed significant differences (p<0.05) between pairs. CSS comparisons revealed elliptical cross sections in anterior arch regions of resistant consumers compared to non-resistant consumers. CA variation and differences in CSS along the arch supports the prediction that loading, and thus the morphology, is non-uniform along the zygomatic arch and that diet type can be inferred from CA and CSS.

**Inconsistent inheritance of telomere length (TL): is offspring TL more strongly correlated with maternal or paternal TL?**

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Telomeres are repeating DNA sequences at the ends of chromosomes. Telomere length (TL) declines with age, and even more rapidly so with in the presence of particular environmental stressors. TL is a marker of growing interest to evolutionary scholars because of its potential roles in senescence, life history allocations, developmental plasticity, and intergenerational plasticity, and is of interest to social scientists as a potential mediating mechanism between environmental and social context and health. Understanding the inheritance patterns of TL is important to help discern its evolutionary significance and for separating environmental from genetic effects. In contrast to most DNA, TL is modified by aging and the environment, and therefore is considerably, but not completely, heritable. Heritability estimates range from 0.36-0.82. Small, early studies of the inheritance patterns of TL suggested substantially greater father-offspring heritability of TL than mother-offspring heritability, while a larger recent study found the opposite. To systematically address this contradictory state of knowledge, I conducted a meta-analysis of available studies. My analysis comprised eight different cohorts, consisting of a total of 1,629 father-offspring pairs and 1,848 mother-offspring pairs. I found that there is no significant difference (p=0.363) between mother-offspring (r=0.36) and father-offspring correlations (r=0.38). However, there was considerable heterogeneity across cohorts (I<sup>2</sup>=81.5%, p<0.0001), suggesting that the variation across studies is not simply attributable to random sampling error. It is unclear what explains this high degree of heterogeneity across



cohorts. I consider several possible explanations and suggest some tests to resolve these issues.

### **The Northern Levantine corridor: the Paleolithic of Lebanon**

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Throughout history and prehistory, the Levant has played the role of a land-bridge connecting continents and human populations and cultures. This role began with the earliest expansions of hominins out of Africa around the beginning of the Pleistocene and continued through the Middle and Upper Pleistocene when the region was occupied alternately (and possibly at times simultaneously) by Neandertals and anatomically modern humans dispersing from Europe and Africa respectively. At the end of the Pleistocene, the Levant formed a corridor through which modern humans crossed into Europe. Yet, even though the Levant is an extremely important region for palaeoanthropological research, major gaps in such research in this region remain. Unlike its southern part, the Paleolithic record of an important area of its northern part, i.e., Lebanon, remains virtually unexplored, with the exception of a handful of surveys and small number of excavated sites. In spite of their relative paucity, these surveys have identified hundreds of sites spanning all periods of the Paleolithic. Moreover, the few excavations illustrate the importance of Lebanese sites in enhancing our understanding of later human evolution. The site of Ksar Akil, for example, holds evidence for some of the earliest associations of modern human fossils with early, and possibly also initial, Upper Paleolithic assemblages. This paper presents a synthesis of the Lebanese Paleolithic record available from published as well as unpublished survey and excavation results. It will also place this record in the broader Levantine context and will discuss future plans for paleoanthropological work in Lebanon.

### **Variability Selection Hypothesis and developmental plasticity in macaques and humans**

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The Variability Selection Hypothesis (VSH) proposes that early Homo gained adaptive benefit from being flexible in novel or unpredictable climates. Increased intra-taxon variation in body size of early Homo populations suggests greater developmental plasticity in these groups. Another primate taxa proposed as similarly adaptively flexible is *Macaca*. We used dental eruption and long bone epiphyseal fusion to test whether macaques are as plastic in these

developmental markers as Homo. Data was collected on 292 *Macaca mulatta* specimens and compared to published data from human populations. The coefficient of variation of macaque alveolar eruption age per tooth per sex was calculated. The range of epiphyseal fusion time was calculated for all macaque long bones and the pelvis. In order to compare to published data for human males, each range was converted to a proportion of total lifespan. Two-way anovas without replication were used to test whether species had similar variation in dental eruption and fusion time. The two species had significantly different eruption variation (males  $F=33.71$ ,  $df=15,1$ ,  $p < 0.0001$ ; females  $F=119.06$ ,  $df=15,1$ ,  $p < 0.0001$ ) with macaques being more variable than humans. The two species also had different ranges in fusion time ( $F=7.28$ ,  $df=13,1$ ,  $p < 0.5$ ) with macaque males being more variable than human males. Assuming that this variation in the duration of these developmental markers is indicative of flexibility, as proposed by the VSH, our data shows that macaques are more flexible than humans. This plasticity may be related to why macaques are so successful.

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### **Estimating body mass from post-cranial remains: an evaluation using a large known-mass sample of modern humans**

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Body mass estimates from skeletal material continue to be an important part of palaeoanthropological and bioarchaeological research and are being increasingly employed in forensic anthropology. A number of equations have been developed for use with post-cranial material, and although these equations are widely used, they have rarely been tested on individuals of known mass. Additionally, assumptions associated with the application of these equations have not been systematically evaluated. Accordingly, this study employed three-dimensional CT scans from a large sample of documented modern humans to test the accuracy of six sets of post-cranial equations. The results were then used to evaluate five hypotheses relating to the relative performance of these equations. Many of the existing post-cranial body mass equations met the criteria for

acceptance as reliable estimators in the male and pooled-sex samples. However, females were not estimated as accurately. In addition, not all the equations performed consistently, or as expected, in each group. Overall, our results suggest that caution is still warranted when estimating body mass from post-cranial skeletal material.

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### **Tradeoffs between reproductive rate and offspring growth in wild chimpanzees**

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Offspring growth is influenced by parental investment, but parents are expected to experience tradeoffs in the allocation of resources between successive offspring. The rate of offspring production is predicted to compromise traits of offspring quality, including growth. Over a reproductive lifetime, mothers may also suffer energetic depletion, resulting in a lower ability to invest in later offspring. We examined these predictions as they related to juvenile body size in wild chimpanzees (*Pan troglodytes schweinfurthii*) in the Kanyawara community, Kibale National Park, Uganda. We assessed body size in juveniles aged 4-15 using residual urinary creatinine excretion, an estimate of lean body mass. Confirming a previous analysis, this index was strongly predicted by juvenile age (females:  $R^2 = 0.86$ , males:  $R^2 = 0.90$ ,  $p < 0.001$ ). We used linear models to generate age- and sex-adjusted relative body size estimates for 24 juveniles sampled between 1998 and 2012. Consistent with our prediction, chimpanzees born after a shorter interbirth interval were significantly smaller ( $r = 0.62$ ,  $p = 0.02$ ). However, this effect was driven by maternal age, which had an effect opposite to that predicted. Older mothers, who had longer birth intervals, produced larger offspring ( $r = 0.46$ ,  $p = 0.02$ ). This was surprising because older mothers had weaker energetic profiles during gestation and lactation. While older females experience constraints on their reproductive rates, their offspring appear to benefit by having less competition with siblings.

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## AAPA Abstracts

**A digital framework for managing research data in skeletal collections**

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In Physical Anthropology, an increasing number of studies relies on large amounts of data. Standards and software tools for structured data collection are being developed. As a consequence, volumes of digital data accumulate on various systems, but pooling these sources remains complicated and time-consuming.

We propose a digital standard for the representation of research data from human skeletal remains, enabling a free exchange between different types of data storage systems. Our aim is to enable institutions holding skeletal collections to curate related data and to make it available for future research.

Our standard is defined as an ontology that represents data as a network of relations between objects and properties, rather than a relational set of tables. It is developed within the Resource Description Framework (RDF) as an integral part of technologies related to the semantic web.

In practice, it facilitates data collection and recording of results. Additionally, it serves as an interoperability layer between existing collection management systems, skeletal documentation software and research data bases. The ontology is extensible, implementing existing data collection standards and allowing researchers to extend these to fit their specific research objectives. This approach reconciles the collections' interest to build up consistent stocks of data and the ambition of researchers to open up new areas of research and methodology.

Here we present the ontology, which will be implemented in a server-based data base application. It is developed in collaboration with established skeletal collections and will be released for free under a permissive Open Source license.

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**Morphological variability of Pleistocene Australian Aboriginal crania: an influence of cultural or biological processes**

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For many researchers the question of why Australian Aboriginal crania demonstrate so much morphological variation poses a conundrum. Alan Thorne argued that the multiple geographic origins of Aboriginal populations are largely responsible for the observed cranial variation. Peter Brown, on the other hand, argues for a combination of a single migration combined with environmental pressures and artificial deformation as the responsible variables. In order to investigate these hypotheses, a range of morphological measurements were employed to compare Pleistocene (Kow Swamp, Coobool Creek, Keilor, Lake Mungo and Nacurrie 1), and 13 Holocene crania. Overlays of the resulting cranial outlines were used to provide 126 visual comparisons between Aboriginal crania, *Homo erectus* crania (Wadjak, Nagandong VI, Peking Man, Pithecanthropus), African Holocene crania and 7 artificially deformed Holocene crania. Quantitative measure of outline differences was provided by calculating the mean plus two times the standard deviation. The analysis of outlines shows a 39.36 percent disagreement between supposedly deformed Aboriginal crania and known deformed crania. The comparisons of these outlines suggest there is no evidence for artificial cranial deformation among Australian Aboriginal populations. Although the cranial morphology of some late Pleistocene and Holocene Aboriginal samples is similar to that of Javanese *Homo erectus* (coefficient of variation 27.98 and 31.45 respectively), the great variability observed in Aboriginal samples suggests that the ancient settlement of Australia by a number of small human populations with distinct genetic characteristics over a period of thousands of years, provides the best explanation for the observed variability in Aboriginal cranial morphology.

**Energetic effects on the long calls of adult male Bornean orangutans (*Pongo pygmaeus wurmbii*)**

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Vocal displays have the potential to convey information about the quality and condition of the caller, even at long distances. We studied adult flanged male Bornean orangutans (*Pongo pygmaeus wurmbii*) to determine the influence of energetic factors on long calling rates. Orangutans are a highly sexually dimorphic primate with a dispersed fission-fusion social organization, a social setting that requires males to signal over long distances using long calls. We

combined behavioral, ecological, and nutritional data collected from June 2004 – December 2009 and May 2013 – August 2015 at Tuanan, Central Kalimantan, Indonesia, to determine the influence of energetic status on long calling rates, while controlling for the presence of other adult males and females. Using nest-to-nest follows (N=200 days) and daily long call rates from adult flanged males (N = 15), we assessed how long call rates varied in relation to travel distances, fruit availability, and energy intake. We found that calling rates were positively related to fruit availability (p<0.05) but not to daily caloric intake. Surprisingly, travel distances were positively related to long calling rates (p<0.05), which may be explained by the association of ranging behavior with other energetic and social factors. We will also present preliminary results on the relationship between physiological indicators of energetics with long calling rates.

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**A test of parasite-host specificity between two closely-related species of Neotropical primate, *Saguinus fuscicollis* and *S. imperator***

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The extent to which parasites can be transmitted between species is a health concern for both human and nonhuman primates. When parasites infect new host species that have no prior behavioral or immunological defenses the results are often disastrous. The potential for primate species to share parasites may be influenced by evolutionary factors, geography, or the extent of direct and indirect contact between them. It is generally expected that two closely-related species of non-human primates that co-occur, associate with one another regularly, and have strongly overlapping social and dietary behaviors should share the majority of their parasites. We tested this relationship with 62 *Saguinus fuscicollis* and 34 *S. imperator*, two congeneric callitrichid species in the Peruvian Amazon. Blood samples were collected from these animals via an annual capture and release program in 2012 and 2013. In 2013, 36 of the 96 individuals sampled were previously sampled in 2012, allowing us to track changes in their parasite infection status across both years. Three macroparasite infections were identified in thin blood smears that have been tentatively identified as *Dipetalonema spp.*, *Mansonella spp.*, and *Trypanosoma minasense* based on morphological characters. While all three parasites are present in the *S. fuscicollis*

population (prevalence of .39, .61, and .28, respectively), only *Dipetalonema spp.* is present in *S. imperator* (prevalence of .44). Thus, contrary to our expectations, it appears that these congeners maintain different blood-borne parasite-host relationships, which is relevant to future discussions of emerging infectious diseases.

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#### **Fusion of the pubic symphysis and the use of Suchey-Brooks in African apes**

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The human pubic symphysis develops, fuses on a late schedule, and degenerates in a systematic way such that it is often considered the gold standard of non-dental aging methods. One of the most commonly used aging systems is that of Suchey-Brooks. It is unknown if humans' closest living relatives, the African apes, share delayed fusion of the pubic symphysis with humans and if the Suchey-Brooks method can be used to age ape pubic remains. Here gorilla (N=20) and chimpanzee (N=25) pubic symphyses from specimens whose chronological age is not known are visually examined, seriated and assigned to the appropriate phase of Suchey-Brooks then correlated with age ranges provided by dental and skeletal fusion.

Fusion of the pubic symphysis in the African apes is maturational, unlike in humans. Therefore, the pubic symphysis is of limited use in aging as it does not extend the ability to age skeletal remains beyond the schedules known for teeth and other bones. The phases of symphysis maturation correlate with the fusion of other bones and the eruption of permanent teeth. Thus rough age ranges can be assessed for phases I-III, but apes are generally mature by phase IV and thus phases IV-VI cannot be correlated with any age group.

Future studies require chronologically aged samples in order to create phases specific to the apes that do not need to rely on correlation with maturational events. The lack of delayed fusion confirms that this trait evolved in the hominin lineage, likely due to obstetric pressures.

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#### **Three prehistoric evo-devo trends and their possible relationship to high-functioning autism in modern humans**

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Three evo-devo trends, which transformed the course of hominin neurological and cognitive evolution, began in prehistoric infants in response to the "obstetric dilemma." Manifestations of these trends are seen in modern babies who, when compared to apes, (1) are slow to develop physically, (2) experience rapid spurts of brain growth during their first year followed by a prolonged period of neurological maturation, and (3) are susceptible to the soothing effects of reassuring tactile and vocal stimuli (e.g., hugs, rocking, baby talk) when physically separated from caregivers. Hypothetically, these trends underpinned the evolution of large and complicated brains, which facilitated the emergence of higher cognitive abilities in hominins, including symbolic language. Here, the presence in humans of a particular form of high-functioning autism, Asperger syndrome (AS), is examined within this evolutionary framework. Data are synthesized from the literature and the author's research on brain evolution, which show that AS entails extreme manifestations of derived traits associated with all three trends, and, further, that people with AS typically excel at the particular kinds of advanced linguistic, artistic, technical, and analytical abilities that evolved in the wake of these trends. The analysis presented here is consistent with the hypothesis that AS is likely to continue increasing in technically or creatively-inclined enclaves of the population because of assortative mating (Simon Baron-Cohen's "geek hypothesis"). In keeping with the neurodiversity movement, viewing AS from an evolutionary perspective suggests that it should be regarded as a natural product of human evolution rather than stigmatized as a pathology.

#### **Hair cortisol, climatic events, and age in wild ring-tailed lemur (*Lemur catta*) troops from the Beza Mahafaly Special Reserve, Southwestern Madagascar**

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Lemur life histories are significantly influenced by environmental change and climatic events, such as drought and cyclone which impact food resources, birth and mortality rates. The measurement of cortisol in hair, time-averaged over the period of hair growth, offers a method to investigate the interaction between broad-scale environmental patterns and stress physiology. We compared hair cortisol profiles of wild ring-tailed lemurs exposed to unexpected environmental events, and considered age effects. Tail hair samples (N=250) were collected from 15 troops across seven sample years with varied precipitation: normal, drought, cyclone, and post-cyclone. We predicted higher cortisol in troops during drought, cyclone, and post-cyclone

years and in subadults compared to older age groups. Using previously validated enzyme immunoassay protocols, we measured hair cortisol and determined significant differences among troops, sexes, and age groups using Kruskal-Wallis nonparametric tests with Student's t post hoc test. As expected, subadult cortisol levels were significantly higher than other age groups (subadults > adults,  $p=0.007$ ; subadults > young adults,  $p=0.0028$ ). Cortisol levels in adults were greater during drought compared to post-cyclone ( $p=.041$ ) and normal years ( $p=.015$ ); however, individuals sampled in cyclone and post-cyclone years had the lowest cortisol levels. Two troops had higher hair cortisol concentrations than other troops, possibly linked to anthropogenic disturbance. Our results suggest hair cortisol levels may reflect climatic effects on intragroup competition, anthropogenic disturbances, and high levels of predation.

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#### **Age changes in humeral asymmetry in Early Medieval period**

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It has been shown that increased mechanical loading has significant effect on CSG properties whereas only little modifies length and articular breadths. However, it remains unclear what is the impact of behaviorally induced mechanical loading prior and during mid-adolescence on % directional asymmetry (%DA) and if the increased %DA in CSG properties during late childhood to mid-adolescence (7–14 years) is accompanied by subsequent increase towards to early adulthood. The sample consists of 18 non-adult and 54 adult pairs of humeri from Early Medieval sites Pohansko and Mikulčice (Czech Republic). We compared %DA of humeral length, humeral distal articular breadth and humeral CSG properties in 35% of length. As expected, %DA in length and breadth during postnatal growth is low (1–4%) and similar to adult values. Contrary, %DA in CSG properties increases between 7 and 14 years by 9% for areas ( $P < 0.01$ ) and by 11% for section modulus ( $P < 0.05$ ). Both areas and section modulus reach final adult %DA between late childhood and mid-adolescence. Thus, the results suggest that asymmetry in lengths and breadths are well set up in prenatal period and are only little affected by postnatal growth and/or mid-adolescent and adult manipulative behavior. In opposite, our results also support the view that the age interval between 7–14 years is the most important period for reconstruction of impact of behaviorally induced mechanical loading in CSG properties and also that adult manipulative behavior has



limited additive effect to final individual asymmetry.

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**Effects of the relative position of the fibula on the cross-sectional geometric properties of the tibia**

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Previous studies indicate that the fibula acts as a lateral strut for the ankle and a support for the distribution of forces acting on the shank. The position of the lower limb in the frontal plane and relative mobility of the fibula may influence the strength of the relationship between the tibia and fibula during load sharing among hominoids. In humans, fibular rigidity is increased in athletes versus controls, indicating an increased importance in load sharing with greater activity.

While these studies demonstrate the utility in studying the fibula as a load bearing bone and in assessing load-bearing patterns related to behavior, the geometric relationships that relate to static mechanical properties are unknown. This study is the first to document the spatial relationships of the tibia and fibula and the effects these relationships have on cross-sectional geometric (CSG) properties in a sample of living subjects whose activity patterns are documented (n = 83). Based on prior evidence, tibial strength properties and cross-sectional shape are expected to relate to the relative anteroposterior location of the fibula, and the distance between the centroids of the two bones.

Preliminary results show that fibular location is related to CSG properties of the tibia. Fibular CSG properties relating to strength and rigidity are greater when the centroid of the fibula is more proximal to the centroid of the tibia. Tibiae are stronger in a mediolateral plane when corresponding centroids of fibulae are more posterior. These trends are compared among individuals habitually practicing different activities.

**Genome-wide data from ancient Peruvian highlanders and the Population History of South America**

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Despite recent advances in archaeology and population genetics, the number of human dispersals into South America and the routes these settlers took throughout the continent remains subject to controversy. The analysis of DNA from ancient human remains has proven to be an efficient tool to get insights into such ancient population dynamic processes. However, ancient DNA research in South America so far has been mostly restricted to the analysis of the mitochondrial control region and samples 5000 years old and younger. While these studies have increased our understanding of the pre-Columbian population history, inferences have been restricted to female population dynamics and have not allowed us to address relevant aspects like admixture and selection properly. Here, we present genome wide data from pre-Columbian Central Andean individuals from various archaeological sites dating from 7000 BC to 1100 AD. Ancient DNA genomic libraries were analyzed employing both shotgun sequencing and targeted hybridization capture approaches. We compare this data with published genome-wide data from ancient and modern Native American populations and reconcile our results with craniometric studies. Our results show a striking genetic continuity in the Andes over at least 8000 years despite observed changes in cranio-morphological variability. Additionally, our observations support the hypothesis of a single-wave scenario, in which the early and later populations of pre-Columbian South America derived primarily from a single source population.

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**The adaptive value of male relationships in the chimpanzees of Gombe National Park, Tanzania**

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In many species of non-human primates, males form friendly social bonds while simultaneously competing with each other for high rank in a dominance hierarchy that determines mating access to females. While studies reveal a clear link between female bonds and fitness in female philopatric species, few studies have investigated such a relationship in males. Those studies that exist suggest that the connection between bonds and fitness may be mediated by coalitional aggression in males, but in chimpanzees coalitional aggression is relatively infrequent. Here, we investigate whether male social bonds themselves facilitate fitness benefits in one population of wild, free ranging chimpanzees. We created indices of dyadic bond strength based on grooming and associations in two-year periods from 1994 to 2011, and used these to determine total bond strength, number of bonds, and betweenness centrality in the grooming and association networks for each male. We ran a linear mixed model to determine whether, controlling for current rank and age, bond strength predicted rank change (measured by Elo score) within each period. Surprisingly, *number of grooming partners* significantly predicted rank change within each period ( $p = 0.02$ ), while total bond strength and betweenness centrality in grooming and association networks were not significantly related to rank change. This suggests that males increase their rank by forming a higher number of grooming relationships with other males, but not by investing in strong grooming relationships. Future analyses will account for the influence of coalitional aggression and investigate the influence of bonds on male reproductive success.

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**First postcranial material assigned to *Agerinia roselli* (Primates, Adapiformes) from Les Saleres (Early Eocene, Catalonia, Spain)**

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*Agerinia roselli* is the only primate documented up to date from Les Saleres (Early Eocene, Pyrenean Basins, Northeastern Spain), type locality of the species. The unknown exact situation of this site, preventing the recovery of additional material, and the scarcity of the remains ascribed to this species in this and other localities of similar age, gives great importance to any material assigned to this primate. Until



today, the only primate fossils recovered from Les Saleres consisted of three partial mandibles (two with m2-m3 and one with p3-p4), and two isolated lower molars. Nevertheless, a new partial talus has been recently found in the classical collection of the type locality, only preserving the talar body. It shows some strepsirrhine synapomorphies such as a laterally sloped talofibular facet and a lateral position of the flexor hallucis longus groove. Moreover, the size of this bone is consistent with the dimensions of the lower molars assigned to this species, confirming its attribution to *Agerinia*. This talus presents a trochlea that is twice as long as it is wide, with a poorly-developed lateral talar process when compared to other adapiforms such as *Notharctus*. Preliminary analyses of this ankle bone show similar morphology to tali of the extinct strepsirrhine *Djebelemur* and the extant *Cheirogaleus*. This finding suggests that *Agerinia*'s locomotor behavior must have been similar to that of extant cheirogaleids. To conclude, it can be said that all the known primate material from Les Saleres belongs to *Agerinia roselli*, including the first postcranial bone presented here.

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#### Sex determination from the human sacrum: A re-assessment

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Curvature and alae morphology of the sacrum has previously been identified as a sex identifier - with the female sacrum being relatively flat for the physiological ability for childbirth, while the male sacrum more curved. Female sacra also have relatively wider total breath than males as well as smaller first sacral vertebra articulation widths. Re-investigation of these features was performed on a sample set of the Terry Collection using measurements of maximum anterior height, maximum midpoint curvature depth, maximum anterior breadth, maximum sacral articulation breadth and non-metric scoring of curvature (rating 1 – 4). Linear measurements and indices were calculated to evaluate the accuracy in sex identification. Discriminant Function analysis results showed that by four group comparison (Blacks and Whites, Males and Females) correct classification was only 54%, while with combined ancestries correct classification was at 75%. The effects on the accuracy were attributed to unequal changes in size between sexes, especially in the Whites. A second analysis was performed to assess this size differential by using cadaver stature as the control. Correct classification in the four group comparison

increased to 70% and in the combined ancestries groups to 83.5%. Sectioning points for the two groups were produced to provide for archeological and forensic use. The non-metric anterior curvature assessment produced no obvious or reliable patterns in the curvature of the sacrum to be warrant a use as a sex criterion.

#### Lactase non persistence among four Chilean populations

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Lactase persistence (LP) is a genetic trait that has been extensively studied since 1960 among different countries and ethnic groups. In Latin America, given that Amerindians would have LP frequencies near zero and European settlers' frequencies close to 60%, the admixture between both populations offers a unique opportunity to understand differential admixture patterns and the relationship between this trait and food habits of dairy intake.

In Chile, the coexistence of different ethnic groups with a particular history of miscegenation and segregation, led us to estimate the gene frequencies for the SNP 13910C>T, associated to LP, in different populations of the country. In addition to genotyping, participants were surveyed in relation to other related variables, such as ancestry, gastrointestinal symptoms and dairy intake.

Four populations, two indigenous and two admixed, were assessed (n=783). Our analysis showed that gene frequencies for LP among these populations were statistically significant. Particularly on the indigenous populations, LP is near 10%, while a frequency close to 60% was found on the admixed ones.

Dairy intake was below the standard nutritional recommendations on the four groups studied, being extremely lower among the indigenous populations. A statistically significant association between milk avoidance and lactase non-persistence was found among the populations.

Our results suggest that low dairy intake is mainly due to the high frequency of lactase non-persistence, but also as a result of cultural dietary traditions and socioeconomic status of the populations.

#### Shape analysis of the distal metatarsal articular surface in cercopithecoids, apes, and humans

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Modern humans are often qualitatively observed to have metatarsal heads that are dorsally "domed" and mediolaterally wide and flat. Despite the intuitive functional importance of these features in forefoot stability during bipedalism, this morphology has not been quantitatively compared to other primates with different locomotor behaviors and foot postures. To confidently use these features to reconstruct fossil hominin locomotor behavior, shape variation within and among extant species requires rigorous comparison and assessment for functional signals. Here we explored shape variation in the distal metatarsus using three-dimensional geometric morphometrics among humans and other extant catarrhines. "Phylomorphospace" was also explored by mapping the molecular phylogeny of catarrhines onto the principal components ordination of Procrustes shape coordinates. Shape differences among species in metatarsal head morphology were well-captured by the first two principal components, and MANOVAs and post-hoc Tukey HSD tests revealed significant differences among clades and serve to separate humans from other species, specifically in degree of dorsal doming. Within quadrupeds, terrestrial species also trended towards more domed metatarsal heads, but not to the extent seen in humans. Phylomorphospace analysis suggests that more evolutionary shape change has occurred in humans compared to that in other taxa with respect to the reconstructed ancestral condition. Specific aspects of the distal metatarsus appear to be morphological correlates of terrestriality rather than linked to bipedalism per se, but the total morphological pattern seen in humans is unique. These comparative results indicate that this methodological approach should prove useful for analyses of fossil primate metatarsal head functional morphology.

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### Metagenomic analysis of Alaskan ice mummies

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The North American Arctic is thought to have been populated by humans approximately 6000 years ago and its genetic prehistory has recently been described. Although burial was never common among these populations, frozen bodies are occasionally found when the ice melts. Such ice mummies are very rare but due to the exceptional preservation of the soft tissues they are an ideal source for retrospective molecular studies.

In this study we present a tissue-specific metagenomic analysis of five preserved bodies dating between the 4th and 16th century AD that have been discovered at different latitudes in Western Alaska: frozen bodies from the villages of Barrow and Utqiagvik and St. Lawrence Island, and a desiccated body from Kagamil Island in the Aleutians.

Benefiting from a new extraction technique, DNA was obtained from fixed, paraffin-embedded tissue samples that have been collected during autopsies of the preserved bodies (performed between 1971 and 2000). Shotgun-sequencing will be performed on an Illumina HiSeq platform and we will be presenting selected human and pathogen DNA results.

Besides allowing to investigate the genetic history and family relationships of the preserved bodies, our study also aims to characterize pathogenic viral and bacterial species that these geographically isolated individuals carried, which is of particular interest in the context of the evolutionary genetics of human pathogens.

### Dietary Change Following Social Transition at Karystos, Greece

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We test the null hypothesis of no change in diet, evidenced by oral health, at Karystos, Greece from the Classical to the Early Roman Period. To test this hypothesis, dental caries, abscesses, and premortem tooth loss were recorded in 106 skeletons. Sixty-four individuals had teeth for observation of dental caries, while only 60 had mandibles or maxillae to assess abscessing and premortem loss. Statistically significant differences (Kolmogorov-Smirnov) in age distributions between all samples made direct comparisons of prevalence unwise. Thus, odds

ratios were calculated for variation in oral health through time, while controlling for age. Odds ratios indicate that oral health improved from the Classical to Hellenistic periods (7.46 higher risk of caries and 1.14 higher odds of abscessing in the Classical than the Hellenistic period), but declined into the Early Roman period (6.8 higher odds of dental caries, 5.5 higher odds of abscessing, and 4.77 times higher risk of premortem tooth loss in the Early Roman than the Hellenistic period). These results do not support the null hypothesis, but correlate well with the agricultural progression of Karystos. Karystos was primarily an agricultural village consisting of several dozen small farmsteads during the Classical period, at which time Karystos established colonies throughout the Mediterranean, possibly receiving tribute from these colonies. During the Roman period, Karystos transitioned to larger plantation farming, and became a major food supplier to Athens. This may have resulted in lower quality diet for the local populous. The impacts of social change on food quality will be discussed.

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### Hair plucking and grooming behavior in two groups of captive bonobos (*Pan paniscus*)

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Grooming behavior in primates has many functions including the maintenance of social bonds and the health of hair and skin. While grooming is seen in both wild and captive primate populations, abnormal grooming behaviors have only been recorded in the captive setting. One such behavior, hair plucking, has been studied in depth for the bonobo (*Pan paniscus*). Hair plucking can be defined as the rapid jerking away of the hand or mouth to remove the hair and often the hair follicle, sometimes accompanied by the inspection or consumption of the hair. This study compared the frequencies, mode of plucking, site of plucking, and the individual differences in two captive bonobo populations housed at the Cincinnati and Columbus Zoos. Combined, these institutions house just over 35% of the total US captive bonobo population. There are wild- and captive-born individuals in both zoos. Both have had success in breeding, providing the opportunity to monitor the transmission of this behavior across generations. While the wild-born individuals at the Columbus Zoo were never observed to hair pluck, the wild-born individual at the Cincinnati Zoo had the highest frequency of plucking, 44.4% of his grooming bouts, and always self-directed. However, as a whole the

individuals at the Columbus Zoo had a higher frequency of hair plucking in grooming bouts, at approximately 21%, than the individuals at the Cincinnati Zoo, at 8.2% of grooming bouts. Differences in hair plucking and other abnormal behavior frequencies can be useful when considering the best management of captive bonobo populations.

### Estimates of sympatric thick-tailed galago (*Otolemur crassicaudatus*) and southern lesser galago (*Galago moholi*) population densities in an Afromontane forest

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Determining population density is crucial to evaluating the ecology and conservation status of species. Nonetheless, to our knowledge, no population density surveys of thick-tailed galagos (*Otolemur crassicaudatus*) or southern lesser galagos (*Galago moholi*) have been reported. We examined sympatric thick-tailed and southern lesser galago population densities at the Lajuma Research Center in South Africa's Soutpansberg Mountains. Lajuma is characterized by a mosaic habitat with Afromontane forest, grasslands, and regenerating forests. We established three transects sampling a range of habitat types and conducted three surveys for galagos between 7 and 22 July 2014. We compiled results from all transects and used Distance 6.2 to calculate galago densities. Additionally, we established five habitat description transects, 100 m in length, along which we assessed tree height, dbh and species for sampled trees.

Combined density for both species was approximately 1.2/ha. Thick-tailed galago population density was approximately .9/ha while southern lesser galago density was approximately 1.1/ha. Galagos were not sighted equally along each transect. No galagos were sighted on our highest elevation transect where trees were shorter and we did not observe any *Acacia* trees. Our results suggest *G. moholi* densities at Lajuma are lower than *G. senegalensis* densities in riverine forests of eastern Africa, but comparable to *G. senegalensis* densities in drier habitats. Given the paucity of data, these results provide baseline information for comparing *Galago* spp. and *Otolemur* spp. densities between habitat types and in areas of differing community composition. Future research at Lajuma should utilize mark-recapture methods to confirm these results.

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### Human Diet and Health in the Fragmented Forests of Madagascar

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The fragmented and continuous forests in the rural commune of Tsinjoarivo, Madagascar have been a site for primatology research since the 1990s. Local communities are both stakeholders in ongoing research projects and the subjects of development work, but no formal baseline data exists for human population health. Such information presents an opportunity to explore how human and livestock populations fit into the disease ecology of landscapes characterized by receding forests. We collected economic, dietary, health, and food security survey data from 25 households and anthropometric data from 51 children within those households. The prevalence of children who were underweight at this site (57%) was above the reported national levels (53%). In contrast, children in Tsinjoarivo were both less stunted (65%) and wasted (12%) than children nationally (88% and 17%, respectively). Based on food security scores, fewer households had moderate to severe hunger (18%) compared to the national estimate (28%). Our results suggest that short-term food insecurity is contributing to underweight in children but that in the long-term Tsinjoarivo's population may be faring better than those in other parts of Madagascar. This is possibly related to the high altitude geography and resource rich environment. Future work will implement longitudinal data collection to investigate the role of seasonality. In collaboration with the NGO SADABE, our integrated research on human and non-human primate health will aid the development of effective conservation and human development projects that support each other.

### Patterns of asynchrony between developmental age and chronological age in utero

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Heterochrony, a developmental change in the timing of events, leading to changes in size and shape, is fundamental to primate evolution. Most heterochronic studies adopt a time scale but suffer from inadequate resolution of the relationship between chronological age and developmental age. Individuals within a species show high levels of morphological variability at each age, even when conception timing is tightly

controlled. Inbred mice provide a useful model for asynchrony in developmental time because they are genetically invariant, produce large litters, and gestate rapidly. Here, we characterize the asynchrony between chronological age and developmental age of embryos by analyzing variation in developmental age within litters of inbred mice. Litters of embryos (N=6) were collected at 24 hour intervals on embryonic days 12-16 (E12-16) and individuals were assigned developmental stage estimates based on 2D morphometric analysis of limb bud morphology following established methods (<http://limbstaging.crg.es>). Our results show that developmental stage and chronological age are more asynchronous earlier in development (E12-E14) with chronologically older litters (E15-E16) showing reduced developmental stage variation. This result is significant for developmental and evolutionary studies because it concerns the two main components of heterochrony: onset/offset time and rate. Importantly, we show that morphological features that develop later in ontogeny (e.g. cranial skeletal features) are likely to be less variable in onset timing than features that develop earlier (e.g. limbs). Our data are relevant to understanding the evolution of multiple derived hominin features (e.g., large brain, limb proportions) that are formed during the earlier periods of development.

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### Odontometric sex estimation using cervical canine measurements. A comparison of an early Neolithic and an early medieval assemblage

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Human canines show a relatively high sexual dimorphism which provides a basis for discriminating male and female skeletal individuals.

We analyzed cervical canine odontometric data of 62 individuals from a Neolithic cemetery (Linear Pottery Culture LPC; Wandersleben, Germany) and 85 individuals from an early medieval (EM) cemetery (Greding-Großhöbing, Germany). Sex determination was based on standard morphological criteria. Cervical canine dimensions were measured with a digital sliding caliper on extracted teeth.

Repeated measurements indicated high reproducibility for buccolingual width (coefficient of reliability (R) = 0.992 and 0.990 for maxillary and mandibular teeth,

respectively), and lower for mesiodistal width (R=0.926 and 0.941).

ANOVA revealed significant differences for sex (P<0.001) and site (P=0.032), whereas the interaction (sex × site) was not significant (P=0.542). Site effect was mainly based on higher values for canine measures of LPC females compared to EM females (Bonferroni adjusted P-values of t-tests between 0.020 and 0.004). No differences between sites existed for males (adjusted P-values all 1.00).

Discriminant analyses led to a correct classification (cross-validated results) of 91.5% for the EM individuals using mandibular canine dimensions and of 78.4% for the LPC individuals using maxillary canine dimensions. Applying the discriminant functions of the EM assemblage to the LPC individuals revealed poor results, especially for females, with correct classification rates of only 56.8%.

Cervical canine dimensions can reliably be measured and may provide a good basis for sexing archaeological individuals. Care should be taken when applying discriminant functions to assemblages other than those from which they were obtained.

### Dietary patterns in archaeological populations from Northern Chile revealed by isotopic analyses

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Archaeological populations from Northern Chile are currently conceived as populations that developed interchange networks among ecological areas like the coastal, intermediate valleys and the Andean highlands. Natural resources, especially food resources, are then expected to show signals from local ecological areas, in combination to foreign resources as a result of interchange. The Tiwanaku presence in this region, occurred during the Middle horizon (A.D. 500-1100), has been hypothesized to shape the cultural behavior of those human groups. Here we show the results of our isotopic analyses of Carbon and Nitrogen (N=102) in osteological collections from the Tarapaca (Pica 8 and Tarapaca 40) and San Pedro (Solcor 3, Coyo 3 and Quitor 6) areas located in the Atacama Desert oases. Our results reveal both local and foreign signals of food patterns. High variance of food pattern was found in the Pica 8 (Tarapaca area, Intermediate-Late period, 950-1450 DC) collection in relation to the other collections, as revealed by multivariate and variance analyses, showing food patterns associated to sea, intermediate valleys and highlands. Gender bias in food consumption was also found in three osteological collections Solcor 3, Coyo 3 and Tarapaca 40, showing higher consumption of



## AAPA Abstracts

proteins in women than men. The effect of ecological areas, local versus foreign (Tiwanaku) influences and gender are here analyzed and discussed.

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**Determinants of social preferences among female chimpanzees (*Pan troglodytes schweinfurthii*) at Gombe National Park, Tanzania**

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In most primate societies, strong and enduring social bonds form preferentially among kin, who benefit from cooperation through direct and indirect fitness gains. Chimpanzees differ from most species by showing consistent female-biased dispersal and strict male philopatry, and females were long thought to have weak social bonds of little biological significance. Recent work in other populations is challenging this view, documenting well-differentiated associations among female chimpanzees. However, questions remain about whether associations are the passive result of spatial overlap or reflect true partner preferences and social bonds. Here, we use the largest dataset on chimpanzee behavior available to assess determinants of female association patterns. We quantify pairwise similarities in ranging, dyadic association and grooming for 624 unique dyads over 38 years, including 17 adult female kin dyads. We modeled association using general linear mixed models, controlling for spatial overlap. We found that association frequencies among females with above-average overlap of core areas correlated with grooming rates, suggesting that associations reflected social preferences for these females. Further, our results show that when available, females preferred kin over non-kin partners for association and grooming, on average. Unrelated females associated more frequently if they had immature male offspring, while presence of female offspring had the opposite effect. Dominance rank, an important determinant of reproductive success at Gombe, influenced associations above random expectation for low-ranking females, who associated preferentially with each other. Our findings support the hypothesis that female chimpanzees form well-differentiated spatial and affiliative relationships, whose potential adaptive value remains to be explored.

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**Using self-directed behaviors to measure perceived predation risk in wild Olive baboons (*Papio anubis*) in Gashaka Gumti National Park, Nigeria**

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Among primates, self-directed behaviors (SDBs) are recognized as behavioral indicators of stress. One stress inducer is predation pressure and several experimental studies on captive primates have demonstrated that SDBs are associated with predator cues. Studies on free-ranging primates have also demonstrated that alarm call frequencies can be used as a proxy for perceived predation risk. Given that such risk should vary across a primate's home range, I predicted that frequencies of SDBs – like alarm call vocalizations – should vary with context. This study examined the potential for measuring perceived predation risk in free-ranging primates using self-directed behaviors in a manner similar to alarm calling. I measured SDBs (self-scratching, body-shaking, yawning, and self-grooming) and alarm call rates in wild Olive baboons (*Papio anubis*) inhabiting ten habitat types within Nigeria's Gashaka Gumti National Park. Kolmogorov Smirnov and post hoc Wilcoxon signed rank tests were utilized to determine whether habitat type (and their corresponding risk index) significantly affected SDB and alarm call rates. The rates of these behaviors were also compared with each other across habitat types. The data showed that group rates for SDBs and alarm calls varied across habitats and were generally performed at higher rates in habitat types with greater perceived predation rate indexes. Statistically significant correlations were found between self-scratching, body-shaking, and yawning with alarm calls. These results demonstrate that self-directed behaviors, like alarm call rates, may be used as an approach for measuring perceived predation risk in primates on a landscape scale.

**Comparative morphometric analyses of a lower deciduous second molar from Qesem Cave Middle Pleistocene site (Israel)**

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The Middle Pleistocene hominin teeth from Qesem Cave (QC) show a mosaic of archaic and modern traits, including varying size patterns. Since they are not yet taxonomically classified, we contribute to the understanding of the morphology of QC teeth through comparative GM analyses of a lower second deciduous molar (dm<sub>2</sub>) labeled I/12a, recovered from an Amudian layer dated to about 300 kyrs.

I/12a was compared to a sample of 33 anatomically modern human (AMH) and Neanderthal (NEA) specimens. 3D surface models for the dental crowns were obtained from  $\mu$ CT data in order to investigate the morphology of crown and cervical outlines, and enamel-dentine junction. These features were analyzed through geometric morphometric techniques.

The PCA analyses for crown (PC1=38.45%; PC2=28.43%) and cervical outlines (PC1=37.76%; PC2=22.86%) distinguished AMH from NEA in shape space. I/12a showed morphological affinities to NEA for both outlines, having a distally expanded crown and a rather squared cervical outline. The shape of the EDJ distinguishes NEA and the other fossil specimens from recent AMH along PC1 (39.26%). Noteworthy, I/12a separates from both groups along PC2 (17.49%) for its particularly elongated marginal edge.

In form space, both I/12a and Qafzeh 15 plot at the highest end of the size range for all traits.

In conclusion, I/12a shared some traits with other Late Pleistocene *Homo*, but also showed a peculiar shape of the EDJ marginal edge that distinguish it from both NEA and AMH. A more geographically comprehensive Pleistocene dm<sub>2</sub> sample would probably shade light on I/12a morphological affiliation.

*Sigfried Ludwig - Rudolf Slavicek Foundation, Vienna, Austria; Dan David Foundation, Tel Aviv, Israel.*

**Stable carbon and nitrogen isotope analysis of early Mississippian diet at Cahokia mound 72**

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Mound 72 is an elaborate ritual/mortuary complex comprised of 26 mortuary features and including remains of over 270 individuals with evidence for elite burials, human sacrifice, and violent death that is central to our understanding of ritual beliefs and practices, and social and political organization at Cahokia. Carbon and nitrogen isotopes of human bones and teeth from



downtown Cahokia provide direct evidence for diet and indirect evidence of social distinctions. Previous isotopic results from Mound 72 (Ambrose et al. 2003) show that diets of high status individuals included less maize and more animal protein than those of mid status or sacrificed individuals. We present new isotope data from 200 individuals and 14 burial locations within Greater Cahokia, including a significantly larger sample ( $n = 72$ ) from Cahokia's Mound 72, and provide critical new information on dietary variation during the rise and fall of this important Mississippian polity. Correlations are drawn with age and sex, archaeological evidence of social status and mortuary treatment, strontium evidence for place of origin (Slater et al. 2014), and new AMS dates. Our results confirm earlier studies indicating lower maize/higher protein diets for high status individuals, and increased maize consumption through time and with strontium isotope evidence for movement to Cahokia. These data provide new insight into the dietary heterogeneity of elite and symbolically significant figures central to current interpretations of the founding, social organization, and symbolic dimensions of the Mississippian political center of Cahokia.

#### Elastic energy storage in the Achilles tendon during running gaits

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Recent research suggests that shorter *triceps surae* moment arms are associated with a lower energy cost of locomotion during human endurance running. Mechanically, smaller moment arms are hypothesized to increase the stress imparted to the Achilles tendon, increasing the total amount of elastic energy stored and returned as kinetic energy, thus reducing energy costs. We test this hypothesis using eastern cottontail rabbits ( $n=16$ ; *Sylvilagus floridanus*) as a model organism. The bounding gaits of *S. floridanus* are characterized by similar spring-mass mechanics as human running, making rabbit bounding a good model for running mechanics in general. We quantified the spring-like behavior of each hindlimb joint using specific net work (SNW: equal to net work/total work) as a metric. Lower values of SNW indicate more spring-like joint mechanics (with 0 being a perfect spring). We found that, controlling for acceleration, the ankle had the lowest SNW of all the hindlimb joints (all  $p<0.05$ ), supporting previous assertions that the ankle behaves as a spring. However, controlling for acceleration and body mass, *triceps surae* moment arm length is not significantly correlated with total ankle work (proportional to the total elastic energy stored and released:  $p=0.32$ ). Our

results suggest that the relationship between *triceps surae* moment arm length and Achilles tendon energy storage may not be as straightforward as previously thought. However, given the established correlation between this variable and the energetic cost of human running, further work in humans is required to fully understand the mechanical basis of these relationships.

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#### Examining Fingerprint Identification through an Anthropological Lens

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Dermatoglyphics are of interest to researchers from a variety of fields; two in particular are physical anthropology and forensic science. The majority of anthropological studies examine the heritability and inter-population variation of Level 1 Detail (e.g. pattern type, total ridge count), while forensic scientists concentrate on individual uniqueness of Level 2 and 3 Detail (e.g. minutiae and pores, respectively) that are used for positive identification. Therefore, results of anthropological studies are mostly irrelevant to latent fingerprint analysis and collaboration between both disciplines is limited to non-existent. The present study seeks to change that. We tested whether minutiae, which vary individually, show any evidence of genetic influence on variation at the group level by examining the effect of ancestry (e.g. population) and/or sex on the quantity and type of minutiae. Bifurcations, ending ridges, short ridges, dots, and enclosures were analyzed. Each minutia type was visually counted on the right index finger of 244 individuals ( $n = 61$  African American ♀;  $n = 61$  African American ♂;  $n = 61$  European American ♀;  $n = 61$  European American ♂). A MANOVA was used to analyze the overall effect of sex and ancestry on minutiae variables. Results show that the overall model was significant (Wilks'  $\lambda$  F-value = 1.76, numDF = 192, denDF = 1623.1,  $p$ -value =  $<0.0001$ ). Therefore, fingerprint minutiae vary by sex and ancestry, like Level 1 Detail. This finding suggests that minutiae could yield valuable information regarding the sex and ancestry associated with a fingerprint in a forensic setting.

#### Morphology and locomotor function of the hominin pubis

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The pubic bone plays an important role in both obstetrics and locomotion. The Neandertal pubis is significantly longer and thinner than that of recent humans, and this difference is suggested

to have an obstetric explanation. However, because Neandertal pubic bones show a different pattern of sexual dimorphism than other hominins, an alternative explanation may be more appropriate.

In this study, we compared a large sample of hominin pubic bones from the Middle Pleistocene to the present from all available data sources. We examined measurements from the pubis and whole pelvis, including measures of body size, stature, and sex where available. We then analyzed these variables within and among each hominin group 1) to determine if Neandertals truly were unique in their pubic morphology and 2) to develop hypotheses for the ways in which pubic variation might affect locomotor function. We also addressed methodological issues in pubic bone analysis involving the use and definition of different pubic measurements.

These analyses demonstrated a need to clarify pubic measurements, including names and landmarks, and determine their reliability using correlation analysis. Analyses of the most reliable measurements revealed that Neandertal pubic rami were significantly longer and thinner ( $p<0.05$ ) than other hominin groups. Elongated pubic bones would increase the lever arm for the adductor musculature, potentially increasing their mechanical advantage.

#### Infant involvement in male agonistic displays in black and white colobus monkeys (*Colobus vellerosus*)

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Male confrontations in *Colobus vellerosus* can take the form of stiff-leg displays targeted at extra-group males. Infants sometimes react to these displays by jumping, climbing and grabbing on the displaying male while squealing intensely at him. Here we investigate whether the context of these interactions are similar to cases of infant involvement in male display or agonism reported in other primates (eg. mountain gorillas 'interpositioning', Sicotte 1995; Tibetan macaques 'bridging', Ogawa 1995; Barbary macaques 'agonistic buffering', Dunbar and Crook 1971). Our study population was the black and white colobus at Boabeng-Fiema Monkey Sanctuary, Ghana. Between May-Oct 2013, we recorded all occurrences of male display during 684 contact hours with 2 uni-male and 2 multi-male groups. We recorded 136 cases of infant involvement during these displays ( $N= 878$ ; 15.5%). Infant participation occurred in 12 out of 53 putative male-infant dyads. Males and infants both initiated interactions. Potential sire-offspring dyads (determined based on male presence and sexual maturity at the time of infant conception) had higher rates of infant involvement than unlikely sires or potential

siblings (GLMM:  $B=0.035$ ,  $SE=0.016$ ,  $t=2.159$ ,  $p=0.036$ ). The role of potential paternity and the context of between-group male agonism distinguish this male-infant behaviour from that found in other species. Maintaining close proximity to and demanding the attention of a protective male could be a tactic for infants to remain safe if and when threatened by extra group males. Thus males might tolerate and encourage infant involvement as a form of paternal care.

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#### **From there to here: Biological distance in prehistoric West-Central Illinois**

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Biological distance analysis for prehistoric West-Central Illinois has grown from a largely descriptive focus to one that has included multivariate tests of statistical hypotheses. Unfortunately, the connection of these statistical hypotheses to population genetic parameters of interest has often been tenuous at best. Even with the advent of the analysis of ancient DNA, there has been a tendency to avoid model-bound methods that estimate population genetic parameters in favor of testing statistical hypotheses. As an example of a model-bound approach, we show using mtDNA haplogroup frequency data from Raff's (2008) and Bolnick's (2005) dissertations, how Approximate Bayesian Computation (ABC) can be used to estimate the migration rate in Wright's infinite island model after assuming the effective population size and number of generations separating an ancestral and a descendant deme.

The  $F_{st}$  estimate based on 39 individuals from the Pete Klunk Middle Woodland site and 47 individuals from the Schild Mississippian site was 0.0492, but it had a large bootstrap confidence interval (lower 2.5% value of 0.0 and 97.5% value of 0.18). Given the uncertainty in the  $F_{st}$  estimate, the ABC posterior for the migration rate was little different from the uniform prior distribution we used for this problem. Even after increasing the sample sizes by 100-fold the posterior distribution was unacceptably broad. We conclude that while the substitution of genetic for biological distance will be useful in the long run, the limitations on sample size, number of samples, and the use of a single polymorphic locus still limit current applications.

#### **Biting off more than you can chew: a regional assessment of diet-induced plasticity**

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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. However, the role of temporal dietary variability has received less attention, specifically the morphological correlates of fallback foods, which are lower quality, difficult-to-process items consumed due to seasonal dietary resources. How such dietary variability affects plasticity in non-masticatory regions, such as the neurocranium, is also poorly understood. Accordingly, there is a significant gap in our understanding of dietary seasonality on patterns of cranial covariation and integration.

Thirty weanling *Oryctolagus cuniculus* were divided equally among three dietary cohorts and raised until one year old. Control rabbits were fed pellets only. Seasonal rabbits were fed pellets and hay cubes for the beginning of the experiment followed by a shift to an all-pellet diet, simulating seasonal reliance on fallback foods. This schedule was then repeated. Annual rabbits were given pellets and hay cubes for the duration, modeling a mechanically challenging diet. MicroCT was conducted biweekly to detail linear and angular changes in calvarial and basicranial development. Results indicate that diet-induced differences in mechanical loading do not influence phenotypic plasticity in the neurocranium, a notable contrast to marked osteogenic responses observed in masticatory elements. This disparity suggests that long-term loading imparts an effect on cranial locations more directly involved in feeding behaviors. It also highlights 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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#### **Presence of nocturnal primates in disturbed forest fragments of northern Madagascar**

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Nocturnal primates (*Cheirogaleus*, *Microcebus*, *Phaner*, *Daubentonia*, and *Lepilemur*) are found throughout Mt. d'Ambre National Park, a large,

continuous humid forest in far northern Madagascar. The purpose of this article is to identify whether these nocturnal primates, much as do two local diurnal *Eulemur* species, also exist in the region's highly fragmented forests. Primates in small forest fragments may be more endangered due to cyclones, human forest use, reduction in forest size and resource abundance, and increased hunting pressure. One of us (BZF) did night walks and listened to nocturnal vocalizations in twenty-eight forest fragments in May-August of 2004, 2009, 2010; MJB used similar methods and resurveyed three of these forests in July 2014. From this work we found: 1) no initial evidence of *Cheirogaleus* and *Lepilemur* in these forests; 2) *Microcebus* in two small littoral forests northwest of Mt. d'Ambre and north in the Cap d'Ambre; 3) *Daubentonia* in the Cap d'Ambre; and 4) *Phaner electromontis* midway between Mt. d'Ambre and the Mozambique Channel. This *Phaner* population was active during the dry season and inhabits a small (<1 ha) fragment, unlike the continuous forest populations that are most active during the wet season. We believe that regional ethnic traditions have kept diurnal lemur populations and forest patch size steady over the last ten years, despite cyclones and evidence of deforestation elsewhere in the region. Yet nocturnal populations appear more sparsely distributed, are perhaps less resilient to forest changes, and fewer local people have seen them.

#### **Vulnerability to novel and zoonotic pathogens in Nigerian red-capped mangabeys**

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As populations encounter novel pathogens, their risks of disease increase dramatically, affecting susceptible life stages and vulnerable populations differently. In this study, we use primates as a model system for understanding how populations respond to new health threats. We measured rate to re-infection with 15 gastrointestinal parasites in a social group of red-capped mangabeys (*Cercocebus torquatus*) following a de-worming event. Intrinsic host traits, such as age, sex and family line interacted with plastic host traits including stress, social rank and degree of social centrality, to impact vulnerability to gastrointestinal pathogens. We also identified a number of parasites with zoonotic potential, prompting a survey of contact between primates and nearby hunting communities to measure risk of human exposure to zoonotic pathogens. Questionnaire responses from 327 individuals in nearby villages showed that 58% percent of participants reported having hunted primates, 87% consumed, 4% collected carcasses and 8% used them for medicinal purposes. Primate hunting was significantly higher in those who report hunting both night and day, sleeping in the

forest, and hunting with a dog. Hunting was significantly associated with low education, large family sizes, having a father who hunts and being of the resident ethnic group. Results show that individual characteristics (i.e. certain sex/age classes, socio-economic status or dominance status) affect the risk of pathogen transmission in people and non-human primates.

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#### **Undocumented border crosser deaths in Florida: Preliminary results**

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The identification of remains of Undocumented Border Crossers (UBCs) is an important challenge facing forensic anthropologists. Current studies have focused on the Southwestern U.S. Because of the geographic barriers surrounding Florida, recovering remains of UBCs is less likely in this location than in the Southwest. This study reports preliminary findings on the deaths of UBCs in Florida and places it within the broader context of UBCs across the southern border of the U.S. The sample of decedents originated from four medical examiner districts in south Florida whose cases were analyzed at the C.A. Pound Human Identification Laboratory. Using a modified version of Anderson's (2008) definition of a UBC, 21 cases met the criteria for analysis. It was expected that the demographic bias for adult males seen in the Southwest would be supported for the Florida sample, but that there would be less demonstrable cases of coyote (smuggler) violence. The hypothesis was supported for this sample as males were more highly represented in the sample than by chance (Binomial Test:  $n=5$  females;  $n=15$  males;  $n=1$  unknown;  $p$ -value= 0.039). 90% of cases were classified as adults ( $n= 19$  adults;  $n= 1$  adolescent;  $n=1$  unknown). 9 of the 21 individuals displayed perimortem trauma, but there is not sufficient evidence to attribute this to coyotes. These results are significant because they demonstrate that the UBC situation is not contained to the Southwest, and further study is required to gain a more complete understanding.

#### ***Cercopithecoides williamsi* shows the earliest fossil evidence for pollical reduction in a fossil colobine**

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The African colobine fossil record is extensive and considerably more diverse than the extant radiation with at least six extinct genera known. Despite several partial crania and associated postcrania, the phylogenetic positions of these extinct African genera are not well resolved. Reduction in size of the pollex is an important character that distinguishes the African Colobina from the Asian Presbytina and extant colobines in general from cercopithecines. Here we report that the partial skeleton of *Cercopithecoides williamsi* KNM-ER 4420 from Koobi Fora, Kenya, dated to 1.9 Ma, shows reduction of its first metacarpal relative to metacarpals II – V similar to that found in extant colobinans (*Colobus* and *Procolobus*), and more so than that of presbytians or cercopithecines. This clearly marks *Cercopithecoides* as a crown colobinan and is consistent with its reduced P<sup>3</sup> protocone and broad M<sub>3</sub> distal lophid, making it the first definitive extinct colobinan genus known.

Postcranially, *Cercopithecoides* shows a number of adaptations for terrestriality, but its reduced pollex and phylogenetic position within crown colobinans all suggest that it is descended from a more arboreal ancestor, strengthening the argument that arboreality represents the primitive condition for colobines. It has been previously reported that the Late Miocene colobines *Mesopithecus* and *Micocolobus* have relatively large, cercopithecine-sized thumbs, confirming their phylogenetic positions as primitive stem colobines. The large thumb of *Mesopithecus* relative to extant presbytians also implies either two colobine migrations out of Africa to Asia or that thumb reduction has occurred in parallel between colobinans and presbytians.

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#### **The prevalence of caries in Bronze Age populations from the Northern Caucasus**

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Oral health and the prevalence of caries in particular has played an important role in investigating ancient populations. This is due to the wide range of information careful analysis of

dental remains provide, including diet, physical stress phases, hygiene awareness and medical knowledge. The increased prevalence of caries is well known as an indicator for the increased consumption of carbohydrates and sugars, thus reflecting certain dietary practices. The availability of relevant food components can indicate particular ecological and economic conditions in the affected populations.

This paper discusses the prevalence of caries in dental remains from the Northern Caucasus, dating from the Middle to Late Bronze Age (ca. 2200-1400 BCE). This timeframe seems to span changes from pastoralism to a sedentary lifestyle in geographically different areas. From one cemetery located in the foothills (Kudachurt 14), 97 skeletons with dental preservation have been analysed. 46.4 % of these individuals show caries lesions, with a range of locations, frequencies and severities. These lesions occur almost equally in males and females and within all age categories, also in young children. This is especially remarkable in comparison with other population groups ( $n=96$ ) from the steppe region, in which the diagnosis of caries is very rare (6.7%).

The presentation will discuss the correlation of caries to potentially triggering diagnoses (interproximal grooving, abrasion), and the significance of caries occurrence in populations which were expected to be based on animal food production.

#### **Intrasite bioarchaeology of the Moundville Cemeteries: Preliminary investigations**

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This research examines how the composite structure of near mound cemeteries at the Moundville Archaeological Site may be attributed to differences and similarities in the corporate kin groups that created them. The study uses information for 98 individuals for whom age, sex, and burial location could be assessed from near Mounds P and G at the site. Information on burial location assisted in classifying individuals buried near the two mounds as being near the plaza, near the palisade, associated with architecture, or anomalous. Mortuary accoutrements were categorized as ceramic, shell, copper, mineral, plant based, stone, and / or faunal. Finally, pathological information was collected and categorized as being metabolic, developmental, nonspecific infection, specific infection, trauma, and / or arthritis. Principle component analysis was used to create visible correlations between the observed variable and the underlying dimensions. Grave goods and pathology variables were entered as Zscores and subject to the Varimax Rotation with Kaiser Normalization. Grave inclusions are found to cluster along wealth (objects potentially accessible to anyone)



and status (related to social/political office) distinctions. Burial location is shown to correlate with both grave inclusion and observable pathology. The significance of this research is that our understanding of the mortuary complex at Moundville currently exists at the scale of the site. No research has been done comparing and contrasting the individual cemeteries within the site to one another. An intra-site analysis of the near-mound cemeteries provides a better understanding of the observed **variability in the Moundville mortuary complex.**

**Central and eastern chimpanzees are characterized by clinal genetic variation rather than a distant subspecies break**

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Geographically isolated populations of the same species are often called subspecies and expected to show some degree of genetic distinctiveness. Our closest living relatives, the common chimpanzees (*Pan troglodytes*), are grouped into four such subspecies: the western (*P.t.verus*), the nigerian-cameroonian (*P.t.elliotti*), the central (*P.t.troglodytes*) and the eastern (*P.t.schweinfurthii*) chimpanzees. However, genetic studies have often relied upon samples of unknown geographic origin and have not consistently found that central and eastern chimpanzees form monophyletic clades. To examine whether the central and eastern subspecies form evolutionary distinct units, we analyzed data derived from noninvasive samples of wild individuals of known provenance. Specifically, we took 283 published eastern chimpanzee microsatellite genotypes from well-known communities and additionally generated genotypes from fecal samples from 185 central chimpanzees across wide parts of their range. Combined analysis of these datasets revealed a strong pattern of isolation by distance across both subspecies. Also, groups within the same subspecies were often genetically more distinct from each other than the least differentiated pair of groups taken from different subspecies. This proportion, however, became much smaller when we simulated a clumped sampling by including only groups that were geographically clustered. Our results are consistent with a close relationship between central and eastern chimpanzees and a possible joint taxon of equatorial chimpanzees. More generally, our results illustrate that conclusions about population structure depend highly on the distribution of the sampled individuals and

emphasize the difficult nature of subspecies definitions.

**Interpersonal Violence, a View from the Huacas de Moche, North Coastal Peru**

CELESTE MARIE. GAGNON. Anthropology, Wagner College.

The human remains recovered from the Huacas de Moche are among the most well known in the Andes. However, our understanding of trauma at the site and more broadly in the Early Intermediate Period of the Moche valley is based on the sacrificial victims recovered from Huaca de la Luna. In order to expand our understanding of violence, the remains of 68 individuals who were recovered from tombs located in the site's urban sectors, and 50 individuals recovered from tombs in the plazas of Huaca de la Luna, were examined. Nine (7.6%) of these 119 individuals sustained traumatic injuries to the head, all but two of which were non-lethal. Although most of the individuals who were affected were adult males, adult females and subadults were not spared. These data indicate that Moche iconography does not provide us with a complete picture of violent acts engaged in by Middle Moche phase people. Significantly ( $\chi^2 p = .001$ ), all of the affected individuals were buried within the precincts of Huaca de la Luna. This pattern suggests that either: only individuals of sufficient social status to be buried in the huaca engaged in sub-lethal violent activity, or that involvement in these activities conferred the status needed to be interred in the huaca.

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**Three-dimensional documentation of human skeletal remains using 123DCatch software: a reliability of distance measurements**

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The recording of the in-situ position of human remains in 3D is an essential method of field anthropology. The most reliable method of 3D measurement in the field provides MicroScribe and total station (TS) when the laser beam is accurately pointed into the center of the prism. Recently, software that create 3D models from series of ordinary photographs taken at various angles has been proposed as an alternative spatial data acquisition method. The reliability of spatial data based on 3D models has not been systematically evaluated. Our aim is to assess the

reliability of distance measurements derived from 3D models and compare them with those calculated from 3D coordinates acquired in the field by TS. We analyzed six 3D models of skeletons generated from 22 photos on average using 123D Catch free software. We used single burial skeletons, lying in a stretched position, excavated at the Medieval sites of Všeruby and Pohansko (Czech Republic). Each 3D model contains 4-14 reference points measured in the field by TS. The mean absolute difference between distances measured in 3D model and distances calculated from TS coordinates ranges between 1.9 and 15.0 mm. The error is highly dependent on the precision of TS measurement. The intra- and inter-observer error of 3D model measurements is low (0.2-1.0 mm). We propose that measurement in 3D model is as reliable as measurement by TS but 3D models can be used for spatial data acquisition after the skeleton is removed from the grave.

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**Evaluating the differential impact of diet and environmental factors on the shape of different cranial regions: perspectives for reconstructing modern human dispersals**

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Cranial phenotypic variation among anatomically modern humans (AMH) is shaped by both neutral evolutionary forces and adaptation to environmental factors. Given that the different cranial regions are integrated but structured as modules that are relatively independent, the relative importance of the factors that shaped modern human biology varies for different modules of the skull. Disentangling and quantifying the differential impact of these factors is of major importance for reconstructing and interpreting AMH dispersals. By applying 3D surface-scan and geometric morphometrics methods (craniofacial landmarks and sliding semilandmarks) to a large sample of skulls (960 specimens) of both prehistoric and modern Australasian and Amerindian populations, this study: (i) simulated geographic, environmental and subsistence distance matrices and test their correlation with morphological distances (Mantel tests, RV coefficients, multivariate regressions); (ii) evaluated the weight of these factors on the morphology of cranial modules and described changes in shape (MANOVA, PCA). Results confirm that climate and diet are significantly correlated to shape variation. Yet the weight of these factors differs depending on the cranial modules analyzed. This work underlines important differences in the results depending on



the type of distances used (based on populations or directly on individuals) and the impact of the choice of multivariate approaches. Mantel tests were particularly weak to detect significant geographic signals in comparison to RV coefficients and multivariate regressions approaches. This study highlights the complexity of evaluating differential impact of diet and environmental factors on the relative impact on different cranial modules and methodological approaches.

**Inflammation, parasite load, socioenvironmental factors and metabolic syndrome on the island of Utila, Honduras**

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Chronic diseases like type II diabetes and cardiovascular disease are at epidemic levels, with developing nations reporting the highest incidence of growth of chronic diseases. While previous studies have established that diet is a driving factor, persistently high levels of inflammation over a lifetime are considered another major risk factor for chronic illnesses, a term coined 'inflammaging'. Despite the global burden of chronic disease, research is relatively monocultural, focusing primarily on lifestyle and diet in developed regions with low pathogen and parasite exposure. Levels of parasite and pathogen exposure vary across regions, and may alter the links between inflammation, infection and chronic illness by altering immune responses and microbiota. Here, inflammation, measured by C-reactive protein (CRP), fecal parasite load, metabolic risk and socio-environmental factors are investigated among Honduran immigrants and Utilian natives on the island of Utila, Honduras. In a sample of 174 individuals, 55% of Utilians and 68% of Honduran immigrants (over 40) have metabolic syndrome, with the population mean for fasting glucose at a pre-diabetic level of 117mg/dl. The tropical climate, lack of proper sanitation, and hastily developed tourist industry have led to persistently high levels of parasites and pathogens, with 70% having a potential commensal, *B. hominis*, 50% infected with other protozoa and amoebas, and 13% infected with helminths. Although parasitic infections were not associated with CRP levels, protozoal infections were significantly associated with elevated LDL and reduced HDL. These results suggest that parasitic infections may play an important role in metabolic risk factors in developing regions.

**Ontogenetic aspects of the femur from the Sima de los Huesos site (Sierra de Atapuerca, Burgos, Spain)**

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The pattern of human growth and development is unique among primates. Therefore, when and how the modern human pattern of growth and development first appeared have been objects of interest in paleoanthropology since the beginning of the field. These issues can be addressed based on femoral development, since the morphology of the femur undergoes several modifications during the growth process, which are reliable indicators of different maturity stages. During infancy, the morphology and angulation of the femoral shaft is altered, which results in the decline of the neck/shaft angle and the formation of the bicondylar angle. Moreover, both, the metaphyseal surfaces of the diaphysis and the epiphyses changes their morphology and size during the growth process. Currently, in the Sima de los Huesos (SH) sample, there are a minimum number of 14 juvenile individuals represented by femora. The aim of this study is to chart the ontogeny of the colo-diaphyseal and bicondylar angles, relative position of the load axis, and modifications in the epiphyses in this sample. Our findings indicate that differences between recent humans and the SH hominins in colo-diaphyseal and bicondylar angles may arise early in ontogeny due to epigenetic factors. Despite some size differences, the sequence of maturation of the epiphyses and the metaphyseal surfaces in the SH femora is similar to that shown by recent humans. These results suggest that the development of the femoral traits analysed here do not differ, at least in mode, between the SH hominins and recent humans.

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**Leadership and collective action in the HRAF probability sample**

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Using the electronic HRAF we evaluate Hooper et al.'s theory of leadership in human cooperative groups against the ethnographic record in a diverse sample of traditional societies. From sixty societies in the HRAF probability sample we coded 1,213 ethnographic texts on a series of variables developed from Hooper et al.'s mathematical model. Specifically, we focused on a leaders' ability to increase group performance and coordination in collective action through supervision, the sanctioning of free-riders by leaders, the emergence of leadership as a function of group size, the preference for a leader by followers in collective activities, and the degree to which leaders receive a

disproportionate share of returns from productivity relative to followers. We use hierarchical cluster analysis to demonstrate patterns of leadership and collective action across societies of various subsistence strategies. Results reveal that 72.8% of texts demonstrating evidence for the five components of Hooper et al.'s model stem from horticultural and intensive agricultural societies. Much of this evidence (41.9%) comes from a leaders' function to increase performance in collective action through supervision. Horticultural and intensive agricultural societies provide 72.3% of evidence for this component. Foraging and pastoral societies are underrepresented in these dimensions of leadership and collective action, accounting for 8.6% and 2.4% respectively, of evidence in support of this model. The ethnographic record suggests predominate theories on leadership and collective action may be limited to specific subsistence strategies. Results from our systematic cross-cultural research design yield important considerations for theories of leadership across human cultural evolution.

**Biocultural consequences of the Spanish contact in the Lambayeque Valley region of northern Peru: Internal enamel micro-defects as indicators of early life stress**

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The present study utilizes dental histological methods to analyze enamel micro-defects as indicators of early life stress and early age at death in Muchik individuals interred at two sites: La Capilla Santa María Magdalena De Eten (CSMME) (n=15) and La Capilla Del Niño Serrano (CNS) (n=15), both located in the Lambayeque Valley region of northern Peru. Individuals interred at CNS date to the Early Colonial Period (A.D. 1533-1610) and individuals interred at CSMME date to the Middle/Late Colonial Period (A.D. 1625-1760), thus allowing for a diachronic perspective to compare stress events between the Early and Middle/Late Colonial periods. Results reveal a lower prevalence at CSMME in comparison to CNS. This indicates that, over time, Muchik individuals may have been able to acclimate to life under Spanish oppression. Stress chronologies suggest that early life stress possibly resulted from inadequate and less than desirable food and/or water available for supplemental feeding during early infancy, especially around the ages of 4 to 6 months. Furthermore, results show that individuals with enamel defects in the form of Wilson bands at both CNS and CSMME died at an earlier age (9.6 years and 4.05 years, respectively) in comparison to those without observed Wilson

## AAPA Abstracts

bands (19.75 years and 8.8 years, respectively). These results underscore the importance of not only regional and temporal studies of the biological consequences of Spanish contact in the Americas, but also the importance of investigating the relationship between early life stress and adult longevity.

#### On the relationship between visual acuity and vomeronasal function in primates

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The “visual priority hypothesis” proposes an evolutionary tradeoff between visual and olfactory abilities in primate evolution. A main prediction of this hypothesis is that acquisition of trichromatic color vision lead to relaxed selection on the main and vomeronasal olfactory systems. Testing this prediction is challenging because comparative studies of main olfactory receptor genes in primates differ in the number of reported functional genes per species and draw from limited taxonomic sampling. By comparison, the genes encoding vomeronasal receptor proteins (V1R and V2R genes) demonstrate clear variation by clade, with haplorhines having reduced numbers of functional genes compared to strepsirrhines. Another key derived feature of the haplorhine visual system is a cone-dense retinal fovea that facilitates high visual acuity. Here we examine the hypothesis that the evolution of higher visual acuity contributed to relaxed selection on the vomeronasal system in primates. We collected data from the literature on primate visual acuity and V1R receptor gene numbers. Data on vomeronasal groove length, which is correlated with the number of functional V1R genes, were collected from serial histological sections and CT scans from primate cranial specimens. We used phylogenetic least squares regression analysis to test for relationships between visual acuity and variables characterizing the vomeronasal system. Our results indicate a significant negative relationship between visual acuity, the total number and proportion of intact V1R genes, and size-adjusted vomeronasal groove length. These results suggest that increased visual acuity may have led to relaxed selection on vomeronasal functionality in primates.

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#### The gripping tale of Gantzer's muscle

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The flexor pollicis longus muscle (FPL) allows humans to flex the thumb phalanges independently of the lesser digital phalanges. Its independence from the flexor digitorum profundus muscle, from which it is embryologically derived (Cho *et al.* 2012), is unique to humans amongst the Hominidae (e.g., Straus 1942). FPL facilitates precision grip and tool manufacture (e.g., Napier 1962). However, because its insertion upon the distal pollical phalanx is difficult to assess on bony anatomy and these are rare in the fossil record, the evolutionary origin of FPL remains unclear. Interestingly, Gantzer's muscle, an accessory head of FPL (ahFPL), is a common anatomical variant in humans. We explore whether the pattern and distribution of Gantzer's muscle in humans yield insight into FPL's evolution. Novel frequency data from LMU-DCOM's cadaver laboratory, 56% of European-Americans (n=72), contrast with observations from other populations; for example, ahFPL was found in 67% of Korean (Oh *et al.* 2000), 62% of Thai (Mahakkanukrauh *et al.* 2004), 46% of Indian (Pai *et al.* 2008), and 45% of English (Abrahams *et al.* 1997) antebrachia. We review the clinical literature to assess potential relevance of ahFPL to adaptive evolution. No correlation of ahFPL with accessory flexor hallucis longus (ahFHL) was uncovered, suggesting genetic and/or developmental decoupling of FPL and FHL, perhaps as a result of the divergent roles of the human pollux and hallux. Finally, we outline directions for future research; most notably, the need to collect additional data on the pattern and prevalence of soft tissue variants.

#### A new calculation of the habitable land area of Sahulland during the Last Glacial Maximum and its implications for hominin population size

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A good deal of Australian archaeology over the past 30 years has focused on late Pleistocene human response to climate change. Many of these studies focus on the Australian mainland alone, and population size estimates have neglected those portions of the Sahul Shelf currently submerged by the ocean, but which would have been exposed as dry and habitable land during the Last Glacial Maximum. We present a new estimation of habitable land area of Sahulland including not only those areas now submerged, but also the landmasses then connected to Australia (Tasmania, New Guinea, and neighboring islands).

Using the polygon creation function in Google Earth, which calculates the area within the

polygon, we estimated the area of Sahulland when sea level was 120 meters lower than today. The land area of Sahulland is estimated at 11,021,024.1 km<sup>2</sup>. Three desert regions of extreme aridity, which archaeological and paleoclimatic data indicate were devoid of human population and barriers to human movement, were subtracted from the estimate. These areas added together are estimated as 1,602,293.3 km<sup>2</sup>. Therefore, we estimate a potentially habitable land area of Sahulland to have been 9,418,730.8 km<sup>2</sup>.

Human population density of Australia at the LGM has been estimated as .5 individuals per 100 km<sup>2</sup>. Using this figure, we estimate human population size during this period to be approximately 47,000 individuals. This estimate assumes that all areas of the continent not designated as barriers were populated. As this is unlikely, our estimate should be seen as a population ceiling.

#### Child experiences of the Great Irish Famine (1845–52): Bioarchaeological insights on the impact of institutionalization at Kilkenny Union Workhouse

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The Great Irish Famine is among the worst food crises in history. Of the estimated one million people who died, 47% were less than 10 years of age. Despite this fact, very little research has focused on the experience of childhood during this period. This paper is discussing bioarchaeological insights of institutionalization of children in Ireland during the Great Famine. The study is based on skeletal remains of 522 children (< 15 years) that died in the workhouse in Kilkenny City between 1847 and 1851.

The Irish workhouse system was introduced following the enactment of the 1838 Poor Law that aimed to provide a “more effectual Relief of the Destitute Poor”. In-door relief was intended to function as a deterrent, and inmates were subjected to a harsh and demeaning treatment which involved hard physical labor, restricted food rations, and age and gender segregation within a strict disciplinary regime. During the Famine, they became the last resort in an attempt to survive starvation and disease for hundreds of thousands of people.

The bioarchaeological study of the non-adult remains from the Kilkenny mass burials have indicated that the institutionalization aspect is a substantial factor to consider when interpreting skeletal markers of stress in this population. This relates not only to morbidity frequencies, but also the mortality pattern observed in the youngest children that is likely to have been influenced by psychosocial stress relating to maternal separation. This occurred when a child was only 2 years of age.

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### **Tarsiers, Omomyids, and New Postcranial Elements of *Teilhardina belgica***

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The phyletic link of living tarsiers to fossil primates has been a difficult bridge to cross. Although Tarsiidae has been linked to fossil tarsiiforms such as omomyids and microchoerids, as well as to anthropoids, no consensus of opinion has been reached. Here we add several new postcranial elements for one of the most primitive of all tarsiiforms, *Teilhardina belgica* from Dormaal, Belgium. We compare this new material to that of living and fossil tarsiers as well as to other Eocene fossil primates. Besides the previously known tarsals for *Teilhardina*, we have been able to add a distal humerus, a proximal ulna, a second metacarpal, a proximal and a distal femur, tibiae, additional tarsals, first metatarsals, and several proximal and middle phalanges. Although most of these postcranial elements compare best with other omomyids, and therefore do not resolve the phyletic relationship of omomyids relative to tarsiers, the fingers and toes of *Teilhardina* are quite elongated, a similarity to living tarsiers. Middle phalangeal lengths of the diminutive *Teilhardina* are comparable in length to much larger species of *Tarsius* suggesting relatively even longer digits. The digit features of *Teilhardina* and *Tarsius* are unusual for primates in general and may in fact represent an ancestral state although hands and feet of other fossil tarsiiforms are needed to test this hypothesis.

### **Spatial variation of dentine hardness in the molars of three primate taxa**

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Little is known about the material properties of dentine across non-human primates. For the development of realistic models of dental function, such data are essential given that dentine is a major material component of teeth. Dentine microhardness was sampled from molars sectioned in transverse, sagittal and coronal planes of *Cercocebus atys* (n= 4), *Macaca fascicularis* (n=4), and *Colobus polykomos* (n=3)

via Vickers indentation. We utilized Moran's I statistic to test for spatial autocorrelation. Of the transverse cuts (n=20), 35% fell below a *P*-value of 0.05 for Moran's I. The incidence of significant positive autocorrelation was much higher for the coronal and sagittal cuts (n=29), where 69% of samples fell below *P*=0.05. Maps of spatial microhardness distribution show that, in general, coronal and sagittal sections exhibit softer dentine centrally compared to peripheral areas (i.e., those nearer mesial, distal or apical margins or near the enamel-dentine junction). No such pattern was discerned for the transverse sections. One-way ANOVA revealed significant differences in dentine hardness between the taxa (*P*< .001), and within taxa, *C. atys* and *M. fascicularis* display statistically significant differences in hardness between planes.

These hardness data provide evidence of significant differences between species, as well as among-plane anisotropy and in-plane heterogeneity within species. Our finding of hardness differences within and between orthogonal planes of section have implications for understanding dentine's role in the maintenance of structural integrity of teeth over the lifespan.

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### **"Race Becomes Biology": Co-occurring Oral and Systemic Disease Processes as Embodiment of Structural Violence in Skeletal Remains**

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In recent years, a large number of biomedical studies have demonstrated that the bacteria that contribute to periodontal disease can migrate outside the oral cavity, causing a host of systemic infections. Yet, to date, only one bioarchaeological investigation has addressed this co-occurring disease process in a past population. The current study confirms the bioarchaeological visibility of the correlation between oral and systemic disease based on data derived from a sample of white and black adults from the Robert J. Terry Anatomical Skeletal Collection (n=197). Vertical recessions and porous remodeling of the alveolar crest were examined to identify periodontitis. Periosteal lesions on the femur, tibia and fibula were used as indicators of non-specific, systemic disease.

As in a previous study of periodontitis and periostitis in a medieval British cemetery, a significant correlation (*P*<0.01) between these disease processes in the Terry Collection sample is reported, suggesting the importance of further work on co-occurring disease processes in skeletal remains. Furthermore, not only are rates of periostitis and moderate-to-severe periodontitis significantly higher among black individuals than white (*P*<0.02 for each disease),

but the severity of each disease process is significantly more severe in the black sample (*P*<0.05 for each disease). These results offer an example of the physical embodiment of structural inequality, highlighting the complexity of disease states as existing in a dialectical relationship with social processes. Finally, I argue that a more expansive and nuanced model is needed for assessing structural violence in skeletal remains than currently exists.

### **Assessing sex and ancestry using cementoamel junction diameters of modern Americans**

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Human tooth crown diameters have been shown to differ between sexes and ancestry groups, providing another tool to estimate the biological profile of skeletonized remains; particularly when bone elements are missing or damaged. The cementoamel junction is an area that is rarely affected by dental wear and more frequently preserved in archaeological and forensic settings, representing a potential alternative to crown dimensions for sex and ancestry assessments. In this study, we assess the presence of sexual and ancestral differences in the mesiodistal and buccolingual diameters at the cementoamel junction of various teeth from modern Americans of African and European descent (n=252). Univariate and multivariate analyses demonstrated the presence of significant differences between both ancestry and sex groups that allow for accurate assessments, especially when one of the factors (either sex or ancestry) is known. Four-way discriminant function analysis rendered a moderate correct classification rate (55.4%, cross-validated). However, when sex was known, ancestry was correctly estimated with accuracies of 69.5% and 72.7%; similarly, when ancestry was known, sex was correctly estimated with rates of 76.1% and 81.6%. These rates of correct classification are comparable to those reported for crown dimensions, indicating that cementoamel junction diameters represent a viable alternative in American populations to equivalent crown measurements, particularly when crowns are worn or fractured.

### **Mapping language networks in the human brain**

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Language, along with its associated cognitive challenges, is arguably the key factor that has driven evolution of the human brain. Uniquely



human language capabilities are associated with both gross morphological changes of the brain as well as with novel neural networks. Endocasts, our only direct evidence of the brains of human ancestors, have revealed a disproportionate increase in size of the cerebellum relative to the cerebrum in recent humans at the same time as advances in material culture are found. Moreover, clinical and neuroimaging analyses have shown that the cerebellum plays a key role in the neural network modulating cognition and language in concert with the cerebrum. The anatomy of this functional network, however, is not understood.

Here, we test the hypothesis that there is direct anatomical connectivity among areas of the cerebrum and cerebellum active during language production. We employed a novel multi-model imaging methodology, using high-resolution structural magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI) to map the complex morphology of the language-specific cerebrocerebellar functional network (LSCN) in 30 right-handed young adult males. Our results confirm anatomical connectivity between discrete regions of the right cerebellum, left thalamus, and left inferior frontal gyrus, which are functionally active during language production. Demonstrating cerebellar connectivity to cerebral language regions advances our understanding of human brain evolution and potential targets of selection. Further, these results lead to new hypotheses about the language capabilities of human ancestors that may be tested through analysis of cerebellar features on endocasts.

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**Innate immune function and oxidative stress as measures of male quality in Cayo Santiago rhesus macaques**

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Condition and health are important determinants of the ability of males to achieve high dominance rank. In primates, in which obtaining the alpha position in the group does not carry high reproductive benefits, males queue for rank, rather than acquire it via high-risk direct aggressive challenges. Whether male condition and health are related to rank in such species is unknown. We investigated the relationship between male rank and condition in a primate characterized by rank-acquisition via queuing –

the rhesus macaque (*Macaca mulatta*). We quantified male condition and health via two measures of innate immune function (bacteria killing assay and hemolytic complement assay), and one measure of oxidative status (lipid peroxidation) in 15 adult males on Cayo Santiago, Puerto Rico. We took advantage of an unusual event in our study group – an alpha position take-over by an immigrant male to examine his quality in relation to the males already resident in the group, who had attained their dominance status via queuing. Surprisingly, regardless of whether we included the new alpha in the analysis, high-ranking males had more robust immune response and lower oxidative damage suggesting they were in better condition than lower-ranking animals. These males also had higher mating success. Mating success correlated with two of our measures of quality but after accounting for rank, the relationships were non-significant. Male condition may thus be associated with high social status even in species, in which attaining and maintaining the alpha position does not critically rely on competitive ability.

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**Interdependence, Risk-Pooling, and Environmental Change in Arctic Subsistence Economies: Ethnographic and Experimental Evidence**

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Most research on the evolution of cooperation focuses on strategic risks—the potential costs and benefits of choosing a strategy in a social context where outcomes are affected by the actions of other individuals. This approach has been useful for identifying factors that diminish risks of cooperation and amplify risks of defection, including rewards, reputations, punishments, cultural norms, and institutions. However, this approach often assumes individuals are independent, inhabiting an environment where cooperation is unnecessary for long-term survival. Environmental risks—spatial and temporal fluctuations in biotic and abiotic components of the environment that affect access to resources, health, and other measures of wellbeing—can affect the viability of independent strategies, altering an individual's strategic calculus in favor of cooperation. Although environmental risks are underrepresented in evolutionary theories of cooperation, research on risk-pooling integrates strategic and environmental risks. We draw on this research and present results from a new field experiment, conducted with common-pool resource users in rural villages in Siberia. Our design builds on a multi-round public goods game, systematically varying strategic and

environmental risks to understand how interactions between these two kinds of risk affect cooperation and risk-pooling. Our results are consistent with previous research, suggesting strategic risks tied to rewards, punishments, and reputations are important. However, we find the effects of strategic risks are altered by the presence of environmental risk, which increases interdependence among individuals. Our research contributes to a growing body of scholarship that examines how environmental uncertainty and change affect social relations.

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**Expanding the network: Low testosterone men have multiple, diverse sources of social support. Evidence from a US nationally-representative sample**

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Although patterns vary across cultures, multiple studies have shown that men in committed partnerships and fathers tend to have lower testosterone than single non-fathers. Evolutionary models on this subject have tended to focus on the facilitating effect of low testosterone on males' cooperation with mothers to raise young. Given the importance of complex group life and prosociality to humans, Gettler recently proposed that we need to consider the broader social network implications of low testosterone, particularly as men transition to partnering-parenting. In this model, men with reduced testosterone should have greater quantity and diversity of social support sources, compared to higher testosterone men. Here, we draw on data from a sub-set of older men (n = 369; mean: 65.7 years of age) enrolled in the National Health and Nutrition Examination Survey, a US nationally-representative study. These subjects had serum total testosterone data and reported the sources from which they receive day-to-day emotional support. Consistent with our hypothesis, men who had the highest number of support sources (4+) had lower testosterone than men reporting zero or one source of support (both p < 0.05). This finding remained significant with controls for age, marital status, SES, ethnicity, and health. Men reporting support from the combination of kin and non-kin had lower testosterone than men in other support configurations (all p < 0.05). Our findings are consistent with notion that low testosterone is downstream of and/or facilitates an array of nurturant, supportive social relationships, at least among older men in the US population.



### Skeletal age estimation for adults: Long-standing problems, recent developments, and a solution

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Age estimation is a critical part of archaeological and forensic skeletal analyses. Yet for 30 years, the field has been divided over the efficacy of age-estimation methods for adult skeletons. Procedures primarily focused on the pubic symphysis and sacroiliac joint continue to be used routinely in paleodemographic and medicolegal contexts, despite studies demonstrating their poor accuracy (correspondence of estimated and actual ages) and precision (age interval length). A recent and quantitatively rigorous procedure, Transition Analysis (TA), yields better results than conventional methods, but it too does not perform to the desired level (Milner and Boldsen 2012). One author compares the accuracy and precision of TA (Boldsen et al. 2002) to three common procedures (Brooks and Suchey 1990, Lovejoy et al. 1985, Osborne et al. 2004) and experience-based age estimates for 55 known-age skeletons (UNM). Another authors shows that in his independent sample of 262 American skeletons the correlation coefficient between estimated and known ages was  $r=0.95$ , and the slope was indistinguishable from the identity line. In both studies, experience-based estimates by a practiced observer have higher accuracy and finer precision than existing methods. To operationalize over a decade of work estimating age by eye, traits throughout the skeleton have been identified for use in a new version of TA. As proof of concept, transition curves for six of over fifty features are presented. Many curves are as steep as features of the pubis and sacroiliac joint, and distributed across the lifespan, making it possible to estimate age throughout adulthood.

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### Structural Resilience: Thoracic Morphology and The Body's Reaction to Long-term Corseting

REBECCA GIBSON, Department of Anthropology, American University.

Seen by modern anthropologists as a restrictive, sometimes violent, imposition on women, the corset both confines and defines the bodies of women during its long period of use. However, skeletal analysis shows the body's resilience and adaptation to long-term corset wearing. This presentation will address primary research done on two European skeletal collections, as it also

incorporates women's own words about their corseting experiences, in an attempt to reevaluate modern assumptions about fashion, work, health and longevity in the Early Modern, Enlightenment, and Victorian periods.

The results of this research, done on populations stored at the Musée de l'Homme in Paris, and the Centre for Human Bioarchaeology in London, shows that women who died between 1700 and 1850, and who show significant deformation of the ribs and vertebrae which can be attributed to corseting, lived longer than the mean age at death for their time. Analysis of data on corsets in the Victoria and Albert museum textiles collection shows a range of dimensions, which—coupled with analysis of skeletal thoracic dimensions—give a picture of women from both well-off and impoverished demographics who lived long lives with significant impairment to their skeletal morphology.

### Review of Olduvai cercopithecoids reveals a newly recognized taxon and biochronological connection to South Africa

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Cercopithecoid fossils have been known from Tanzania's Olduvai Gorge since the 1930s, with multiple taxa documented, including *Theropithecus oswaldi*, *Cercopithecoides kimeui*, and a number of other papionin and colobine specimens less clearly attributable to species or even genus. Since the 1970s, a small number of large papionin fossils, including a partial male cranium and partial female skull, have been identified as potentially representing an early form of the modern genus *Papio*, but noted as distinct from extant baboons as well as other fossil *Papio* species from East and South Africa. In 2013 we reviewed the Olduvai cercopithecoids at the National Museum of Tanzania. Quantitative and qualitative comparisons of the Olduvai material with fossils from both East and South Africa largely confirmed previous observations, with one very notable exception. Our results suggest that the large papionin from Bed I previously allocated to cf. *Papio* sp. nov. is more properly recognized as *Gorgopithecus* sp. based on numerous shared derived features with *Gorgopithecus major*, a taxon previously known only from South Africa. Shared features between the Olduvai specimens and *G. major* include relatively short nasals, concavo-convex tubular nasals, antero-posteriorly curved upper incisor roots,

downwardly oriented brow ridges in the midline, robust zygomatic arches, and overall large size. The recognition of *Gorgopithecus* in Olduvai Bed I, a well-known horizon with precise radiometric dates at ~1.8-1.9 Ma, provides an important biochronological link with South African localities including Kromdraai A, Swartkrans Member 1, and possibly Swartkrans Members 2-3, Cooper's A, and Cooper's D as well.

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### Inter-individual variation in communal hunting in three wild chimpanzee communities

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Chimpanzees hunt red colobus monkeys in groups and share the kills, presenting an apparent collective action problem (CAP). In at least two communities (Kanyawara (Kibale National Park) and Kasekela (Gombe N.P.)), the presence of particular chimpanzees increases the probability that a group hunts upon encountering prey. The 'impact hunter' hypothesis proposes that hunting by these males reduces hunting costs for others via by-product mutualism, thus 'solving' the CAP. This predicts that 1) community-wide hunting rates will decrease following the death of an impact hunter and 2) impact hunters will have higher hunting rates at all ages than other males. We used fifty-five years of data from Kasekela and Kanyawara to test these predictions. At Kasekela, hunting probability was lower in the period following impact hunter Figan's death than the period preceding it (Exact Wilcoxon Signed-Rank Test,  $V = 35$ ,  $p = 0.008$ ). As a prime-aged male, Figan's hunting probability was almost double the mean; earlier data remain to be extracted. Another Gombe impact hunter, Apollo, had above average hunting rates as an old male, but not as a young or prime male. At Kanyawara, impact males Imoso and Johnny both had considerably higher hunting rates than average as prime and past-prime males. We also use 15 years of data from the Mitumba community (Gombe) to examine individual hunting patterns in a small community that hunts frequently.

## AAPA Abstracts

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**Is employment status cross-culturally associated with cognitive function among older adults: Results from the Study on global AGEing and adult health (SAGE)**

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Retirement is traditionally thought to increase leisure time and reduce stress, thus improving health. However, ceasing work may also decrease daily social and mental stimulation in older adults. Previous research in high income nations indicates that loss of work-related problem-solving tasks and social interactions may exacerbate cognitive decline in retired individuals. Still, it is unclear whether this relationship is present in lower income countries. Here, we present results from the World Health Organization's Study on global AGEing and adult health (SAGE) Wave 1, a cross-sectional analysis of adults >50 years old in China, Ghana, India, Mexico, the Russian Federation, and South Africa. Self-report questionnaire data provided information on employment status (n= 34,444), while five cognition tests were used to create a summary variable of cognitive function (n=32,022). Linear regressions were used to examine the relationship between cognitive function and employment status by sex and country while controlling for age, education level, and health conditions known to affect mental acuity. Retirement was significantly associated with lower cognitive function in men living in South Africa and Russia ( $p < 0.05$ ). No significant associations were observed in women, although a non-significant association was observed in Russia ( $p = 0.051$ ). These results suggest that retirement may not have the marked effect on cognition documented in wealthier nations; instead, cultural factors (for example, typical activities and level of social engagement) may differentially structure this relationship by country. Further research is needed to elucidate how culturally-distinct activity or behavior patterns influence cognitive function in retired individuals.

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**Unique morphology found in the first tarsal bones of *Antillothrix bernensis*, a medium-sized Caribbean platyrrhine subfossil**

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Underwater caves in the Dominican Republic have produced skeletal remains attributable to *Antillothrix bernensis*, including a complete astragalus and partial calcaneus. From these elements, body mass and length estimates were reconstructed using platyrrhine-only joint surface area regressions. Mass estimates yielded from astragalus facets averaged 4600g, with a body length of 450mm; calcaneal facets yielded similar estimates of 5000g and 460mm. *Antillothrix* falls in the conspicuous body size gap between the largest modern cebids and the smallest atelids.

*Antillothrix* also exhibits a unique tarsal morphology, illustrated by a 3D geometric morphometric analysis of ~100 platyrrhine astragali and calcanei. Astragalus variation in the medial and lateral tibial facets distinguishes this taxon, with *Antillothrix* occupying an intermediate morphospace between atelids and cebids. The notable curvature and expansion of the distal medial tibial facet suggests a foot well suited for abduction during dorsiflexion, a behavior more in line with climbers than leapers. The distal calcaneus supports this interpretation with more atelid-like, continuous proximal and distal sustentacular facets. No clear morphological features indicating leaping are present in these ankle bones, although similarities with the highly derived callitrichines suggest that *Antillothrix* might have utilized a novel suite of foot postures not observed in modern platyrrhines.

Phylogenetically, *Antillothrix* lacks ankle characters of the clearly derived atelids; their shared traits are likely convergent and attributable to large body size and/or similar positional behaviors. Notable features of the *Antillothrix* ankle most closely resemble one or another group of cebids; the calcaneus is more callitrichine-like, and the astragalus more cebine-like.

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**How to survive the glacial apocalypse: bugging out in late Pleistocene Central Asia**

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Previous research concerning the biogeography of hominin populations in Central Asia indicates persistence across interglacial/glacial sequences. Hominin groups are present on the landscape during the coldest episodes of the Last Glacial Period. Moreover, the Inner Asian Mountain Corridor (IAMC) perhaps served as a geographic conduit for human groups that found refuge in the foothill regions of the Altai as well as those of the southwestern horn of the Tien Shan; this conduit can be construed as the stage upon which hominin admixture occurred. The present study broadens the geographic focus of previous work to include the steppe and steppe/desert zones immediately adjacent to the biologically productive foothills of the IAMC. Our working hypothesis is that hominin groups were only able to persist in steppe regions during interglacial periods, while still remaining closely tethered to low altitude mountain ecosystems. Using an ecological threshold model, abiotic variables in relation to hominin site locations are analyzed to examine differences in fundamental niche structure when the IAMC is compared to the adjacent steppe/desert zones. This preliminary model of hominin-environment interactions serves as a useful example for the ways by which large scale hominin dispersal trajectories are mapped and interpreted. Issue of scale and the implications of extrapolating from single observation points to long distance human migration models will be discussed.

**Uncovering ancestry: Public attitudes toward genetic ancestry testing**

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As direct-to-consumer (DTC) genetic testing has become cheaper and more accessible, experts have expressed concern about the risks and limitations of these tests. This study investigates public perceptions about DTC genetic testing. A nationally representative cohort of individuals (n= 2940) were recruited through an online survey company to complete a questionnaire about their perspectives on DTC genetic testing. Quantitative responses to a series of questions about perceptions about genetic testing were analyzed and compared to demographic factors. Additionally, two independent investigators coded qualitative survey responses about why respondents would or would not purchase a genetic test and achieved consensus (Kappa=0.98). The most common themes from the dataset were related to medical concerns, high costs of tests, and general curiosity about ancestry or other traits. This poster focuses on responses related to ancestry, genealogy, and ethnic origins. Respondents indicated that DTC genetic testing could be useful for discovering interesting information about their families and

genetic past; however, they also expressed concern about potential negative consequences like a breach of privacy or the potential for harm. The majority of younger people (57.6% of participants aged 18-24 years; 63.3% of participants aged 25-34 years), Hispanics (65.8%), and males (57.5%), were more likely to agree than disagree that they would buy a test to find out more about their ancestry (all  $p < 0.001$ ). This preliminary study sheds light on public concerns about DTC genetic testing and serves as a starting point for further research to gain a more thorough understanding of these concerns.

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#### **Predicting M1 Crown Area from dm2 in Modern and Fossil *Homo***

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The deciduous second (dm2) and permanent first (M1) molars are remarkably similar. The relationships between these two teeth in both trait expression and shape have been recently explored. However, their crown size relationship has not yet been studied. This is an important question, especially in cases where only deciduous elements are found. An estimate of size of the M1 from the dm2 analog would allow comparison with larger samples of permanent teeth, which is especially important when dealing with the fossil record. In this study, we focused on the mandibular molars and used simple regression models to predict the size of an individual's M1 based on the size of its dm2. Crown areas were measured and recorded from occlusal photographs of dm2/M1 pairs in 22 recent *Homo sapiens*, and 6 Fossil *H. sapiens* individuals. Not surprisingly we found strong and significant correlations between the sizes of dm2 and M1 ( $r = .77$  and  $.86$ , respectively). While the regression equations were similar for recent and fossil *H. sapiens*, the recent *H. sapiens* equation predicted larger M1s than the fossil *H. sapiens* equation. When either *H. sapiens* regression was applied to known Neandertal tooth pairs, erroneous results were found. This indicates that a separate regression model should be developed for Neandertals. We suggest that in the case of an isolated dm2, regression models can provide valuable estimates for predicting the size of M1, but that this model must be based on an taxa- and age- appropriate sample.

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#### **Changing Perspectives on Social Relations at Neolithic Çatalhöyük: Evidence from Cranial Trauma**

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Neolithic Çatalhöyük is often characterized as an egalitarian and peaceful society. Recent work focusing on cranial trauma suggests otherwise. We have identified a number of depressed fractures and a smaller number of penetrating injuries in crania from the site. All injuries are well-healed, with the majority located above the hat-brim line, a location highly consistent with non-fatal assault trauma. The frequency and location of these injuries is similar to those found more recently in urban populations. They are thus not ascribable to accidental trauma due to their repetitive patterning. Cranial fractures are found in both males and females, and in one adolescent of 15 years of age at death. Several individuals appear to have been recidivists (i.e. having sustained more than one traumatic injury). The social context of these traumatic injuries is, at present, uncertain. We entertain the possibility that these visible signs of injury may have had both symbolic and strategic meaning acting as leveling mechanisms to maintain social boundaries.

#### **Comparing morphometric methods in *Macaca mulatta* crania**

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Accurate, precise, cost-effective methods of measuring skeletal remains are vital to biological anthropology. We compared the precision of a newer method, 3D photogrammetry with Agisoft Photoscan, to that of two other well-known methods for collecting 3D landmarks: Microscribe 3DX and Nextengine Laser Scanner. Landmark editor was used to place landmarks on laser and photoscans. Two crania (one male, one female) of *Macaca mulatta* from the University of Oregon Comparative Primate Collection were digitized by two users (RG) and (KC) who each collected 10 replications with all three methods using a well-established 45 landmark protocol. The 120 replications were then analyzed with generalized Procrustes analysis (GPA) in Morphueus with scale restored. An external scale factor was applied to the photoscans to make them consistent.

To assess the overall magnitude and patterning of the three different methods, the Principle Component Analysis (PCA) and scores were

compared. PC 1 (46 % variance) separated the two specimens. PC 2 (16 % variance) separates the two specimens by user. PC 3 (6 % variance) sorts the Microscribe from the other methods. There is some significant separation within user based on method ( $P < .0001$ ) but this was much smaller in magnitude than the other factors. Between the three methods the laser scans had the best precision (0.42 mm), followed by photoscans (0.67 mm), and least precise was microscribe (0.62 mm). Our results indicate that photostan is as precise as well-known methods, has a similar tendency for user error, is cost-effective, but is also labor intensive.

#### **A biomechanical perspective on variation in molar emergence ages in Primates**

HALSZKA GLOWACKA and GARY T. SCHWARTZ. Institute of Human Origins, Arizona State University, Tempe, AZ, USA.

While it is well established that ages at molar emergence are strongly correlated to life history variables across primates, an understanding of what structures variation in molar emergence ages is lacking. In adult anthropoids, teeth are positioned anterior to the muscle force vector produced by the jaw adductors (i.e., the muscle resultant) because biting posterior to the muscle resultant would distract the temporomandibular joint (TMJ). Here, we tested the hypothesis that the position and timing of molar emergence is constrained to avoid TMJ distraction throughout ontogeny. We predicted that molars emerge anterior to the muscle resultant and that interspecific differences in emergence schedules are a result of changes in the duration of growth and the rate at which space, anterior to the muscle resultant, becomes available.

3D coordinate data, describing biomechanically relevant aspects of the masticatory system, were collected on cross-sectional ontogenetic samples of chimpanzee ( $n=45$ ) and human ( $n=36$ ) skulls. Results indicate that molars emerge significantly anterior to the muscle resultant in both species. Later molar emergence in humans is achieved through growing a mandible at a significantly slower rate and for a longer duration than in chimpanzees.

Our study suggests that the position and timing of molar emergence is biomechanically constrained and that variation in emergence schedules can be achieved by altering the rate and duration of mandibular growth. A survey across primates is warranted to more fully investigate whether this mechanism has structured variation in the timing of molar emergence in this clade.

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## AAPA Abstracts

### Differences between leaders and non-leaders in small-scale warfare and implications for collective action

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Little is known about differences among participants in small-scale warfare. This study uses data obtained from fieldwork with nomadic pastoralists in southwest Ethiopia to investigate characteristics of leaders compared to non-leaders in small-scale warfare. The study population practices warfare primarily through raids that range in size from four to several hundred participants.

Using data from a sample of 12 raids involving over 100 participants and 39 raids with fewer than 35 participants, I identify leaders and assess differences between leaders and non-leaders. Leaders of large raids face a significantly higher mortality risk than leaders of small raids. Leadership in large raids is associated with membership in senior age groups but raid participants include members of all adult age groups. Small raids only include men from younger age groups but leaders of small raids are above average in age when compared to other members of the raiding party. Leaders do not differ from non-leaders on anthropometric assessments. Using several ranking tasks, I found that leaders of small raids are not high-status compared to other participants, while leaders of large raids have high status. Large raiding party leaders are also identified as community leaders while leaders of small raiding parties are not. These differences suggest leaders of small and large raids may have differing motivations: small raid leaders may be motivated by the possibility of livestock and status acquisition, while leaders of large raids may be motivated by maintaining access to livestock and territory.

### Regional Variation in Osteon Size at the Femoral Midshaft

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During the last half century, various researchers have demonstrated the size of secondary osteons to be a useful variable in addressing many questions of anthropological import. Osteon size can help distinguish bone fragments as human or non-human, demonstrates a significant relationship with human chronological age, and has been suggested useful in interpreting biomechanical strains on bone. However, when measuring osteons at the femoral midshaft, little attention has been paid to potential regional variation in osteon size. Recent research in our lab demonstrates there is significant spatial heterogeneity in cortical remodeling rates and

density at the femoral midshaft. This research sought to examine if this regional variation extends to osteon area (On.Ar) as well.

Ten femoral midshafts from modern male cadavers (aged 29–97) were imaged and digitally subdivided into anterolateral, anteromedial, posteromedial, and posterolateral quadrants. Within the periosteal third of each quadrant, 100 intact secondary osteons were measured using geographical information systems (ArcGIS 10.1) software. An analysis of covariance (ANCOVA) was used to examine On.Ar by quadrant, controlling for age related effects. The ANCOVA demonstrated mean On.Ar is significantly different between quadrants ( $p < 0.001$ ). The anterolateral quadrant of the femur, which has the highest remodeling rate, consistently has the smallest mean On.Ar ( $\sim 35,000 \mu\text{m}^2$ ). The mean On.Ar for each of the anteromedial, posteromedial, and posterolateral quadrants was significantly larger than in the anterolateral quadrant, with values consistently between  $\sim 42\text{--}44,000 \mu\text{m}^2$ . Based upon these results, it is suggested that future research should employ sampling strategies that account for regional variation in osteon size.

### Senescence changes in palatal suture fusion across populations: applying a revised scoring method for age estimation using transition analysis

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Age estimation from human skeletal remains continues to be a thorny issue vexing forensic scientists and bioarchaeologists alike. Transition analysis, a newer method that determines the ages at which an individual transitions from one morphological indicator stage to the next has been proposed as a solution to some of these problems and as an alternative to traditional aging methods. The benefits of transition analysis are many: it avoids age mimicry, is appropriate for small sample sizes, may be applied to any morphological trait that changes with advancing age, and forms the basis for subsequent Bayesian analyses. By applying this methodology, the age intervals for each stage should reflect the senescence changes in the population under study, and thus increase the accuracy of the ages assigned to the skeletons.

This research used a revised method for aging from the palate based on an improved system for scoring suture fusion in five regions. These scores were summed and combined into 7 statistically meaningful phases. This method was applied to three modern male populations: Portuguese ( $n=202$ , Coimbra), Americans

( $n=361$ , Bass Donated), and Italians ( $N=141$ , Torino) to evaluate potential differences in the relationship of palatal suture fusion to age across populations. Results of Komolgorov-Smirnov tests indicated the overall age-at-death distributions and some within-phase distributions were significantly different between populations. However, the resultant transition analysis parameters were surprisingly similar for each group, indicating that the new scoring system, coupled with transition analysis, was able to model the morphological changes with increasing age in the palate.

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### Did climate change trigger megafaunal extinctions in Madagascar?

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Holocene megafaunal extinctions on Madagascar are widely believed to have resulted from a synergistic combination of natural climate changes and human impacts. The island is presumed to have been considerably wetter than it is today before humans arrived, but to have suffered prolonged aridification beginning around 3500 years ago, and spiking around 950 years ago. Increasing aridification could have impacted megafauna when human presence was trivial or non-existent, and would have had increasingly dire consequences as human populations grew. Here we use nitrogen isotope ( $\delta^{15}\text{N}$ ) values in vertebrate bone to test this presumption. We measured  $\delta^{15}\text{N}$  values from over 230 radiocarbon-dated subfossil bones from 23 vertebrate genera ranging in geological age from  $\sim 30,000$  to  $\sim 700$  calendar years before present (after which megafauna were rare across the island) to track regional changes in moisture over time. Our samples are geographically widespread, coming from subfossil sites in four ecoregions (spiny thicket, succulent woodland, dry forest, and central highland). Because  $\delta^{15}\text{N}$  values are influenced by diet (which in turn varies across genera) and by other factors such as soil salinity (coastal sites tend to have higher  $\delta^{15}\text{N}$  values than inland sites), we also took these variables into account. Nitrogen isotope values are well predicted by ecoregion, genus and soil salinity, but not by time. Indeed, once ecoregion, genus and soil salinity are controlled, there is remarkably little variation in  $\delta^{15}\text{N}$  values over time. Therefore, our data do not support the notion that natural change in moisture triggered megafaunal extinctions.



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**Evidence for the peopling of South America: archeological and genetic perspectives**

AMY GOLDBERG, ALEXIS M. MYCHAJLIW, DELANEY SZTRAICHER and ELIZABETH A. HADLY. Department of Biology, Stanford University.

As the last major continent colonized by humans and the stage for a Late Pleistocene megafaunal extinction event, a firm understanding of the peopling of South America is of clear importance, yet has received comparably little attention. To address this deficit, we compiled a new dataset of 900+ published radiocarbon dates older than 8,000 years before present. Our dataset has been re-calibrated using the ShCal13 curve (probability  $\geq 95\%$ ) and includes 200+ unique archeological sites spanning the continent. We jointly analyze these data with published genome-wide SNP data from 30 South American indigenous populations (Reich et al. 2012, Nature). Methods are implemented using the R package *spatstat* and ArcGIS. To describe movements on a broad scale, we evaluate the density and direction of spread of archeological dates over time. Surprisingly, the earliest known sites appear concurrently throughout the continent, rather than a north-south progression along the western coast. Considering water routes, elevation, and terrain ruggedness, we compare least-cost pathway migration route estimates based on archaeological data to those inferred from genetic data. While we find support for previous assertions of a coastal migration, there are clear biases due to sampling, excavation, and preservation. We emphasize analyses demonstrating a need for increased excavation in specific geographic regions, and at lower levels of known sites. This work creates a novel framework that incorporates two distinct types of data to make demographic inferences about the initial colonization of South America, and acts as a resource for future archeological studies on the continent.

**Studying Mississippian Societies in the Lower Illinois Valley: What We Have Learned & What We Need to Know**

LYNNE GOLDSTEIN. Department of Anthropology, Michigan State University.

Archaeologically, the Lower Illinois River Valley is best known for Middle Woodland societies, and much has also been written about Late Woodland cultures. However, the region also was home to Mississippian societies (ca 1000-1200 CE), although these are not as well known. In particular, Moss and Schild cemeteries, portions of the Yokem site, and portions of the Koster site have yielded

significant information on Mississippian societies outside the mainstream of Cahokia. One can often isolate and better understand sites on the periphery, which has less complexity. Using Moss, Schild, Yokem, Audrey, and Koster sites, this poster outlines how archaeology in the region has contributed to identification of key components of Mississippian mortuary ritual, including Mississippian structural elements such as spatial relationships between settlements and mortuary sites, presence of rows, charnel houses, selective and specialized use of cremation, and extensive processing of human bone. Identification of these components has allowed us to understand and identify the structure of Mississippian mortuary ritual at larger, more complex sites, as well as the relationship between sites. One reason Mississippian in the region is not better known is that in 60 years of archaeological research, few portions of the area have been systematically statistically sampled via archaeological survey. With the addition of some large highway projects that forced systematic survey, this picture is changing, but the poster outlines what we have learned thus far, and what must be done to expand and improve our knowledge of Mississippian societies on the periphery.

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**Stature estimation from modern Southeast Asian skeletal remains: Placing the data in context**

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Estimating stature in skeletal remains of Asian ancestry, especially individuals from Southeast Asia, is problematic due to the lack of population specific data. This research seeks to develop more accurate and statistically robust stature estimations using the anatomical method. Skeletal height was calculated in 50 individuals (25 males, 25 females) from the Khon Kaen University Osteological Collection in Thailand. These 19th and 20th century individuals, predominantly from Thailand and regions of Laos and China, come from a body donation program with known age-at-death. Results indicate that the most accurate elements to use in the estimation of stature in this sample population is the combined use of femoral and tibial length. Moreover, the study compared data on average attained heights from the Khon Kaen skeletal population with public health data (Jordan et al., 2010) taken from individuals born in the mid-20th century to allow for the validation and contextualization of our stature estimation methods. Our data indicate that the average living stature estimate in both males and females is approximately 10 cm shorter than the aforementioned public health data. Possible

explanations for these discrepancies will be identified and discussed. Beyond developing more accurate methods of stature estimation, this research also seeks to address growth, development, and health at the population level, as well as, secular changes in height in Southeast Asia over the last century.

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**An analysis of estimation of maximum length in incomplete long bones**

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Estimating length of incomplete long bones is an inevitable part of many bioarchaeological studies in order to maximize sample sizes. However, little attention appears to have been devoted to assessment of its reliability. Therefore, three methods of estimation were examined to investigate this concern.using long bones from a historic Maya population.

Fifteen incomplete humeri, femora, tibiae and fibulae with complete counterparts were used. Twenty-four participants with varying levels of osteological experience were asked to reconstruct maximum length by 1) "eyeballing" the perceived length, 2) estimating it using complete bones as comparative material, and 3) applying regression formulae of Wright and Vasquez (2004).

Mean difference between estimated and actual lengths as percentage of total length was 3.28% using Method 1 and 2.83% using Method 2; standard deviations were much larger with the first method. Humerus estimations exhibited the largest differences, averaging 4.17% for both methods whereas the tibiae estimates varied by only 1.15%. Humeral lengths were consistently underestimated, but those for other bones showed a mixed pattern of estimated values. Estimates using regression formulae deviated most from actual values with differences averaging nearly 11%, likely due to difficulty in consistent identification of landmarks. The effect of scoring experience varied, but was most reflected in accuracy of eyeballed estimations.

These findings indicate the femur and tibia provide the most reliable estimates and use of comparatives increases accuracy. Although differences between estimated and actual length were smaller than anticipated, levels of variation suggest that their inclusion in analyses must be done with caution.

### Diet-microbe co-metabolic interactions in wild primates reveal clues on human evolution

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Recent advances in microbiome studies and meta-“OMICS” have offered new molecular insights into how host-microbe systems impact mammalian physiology. Here, we test the hypothesis that the molecular characterization of diet - gut microbe interactions in wild primates also provides valuable information on the factors that triggered human evolution. Thus, we use a longitudinal approach, along with high throughput sequencing and metabolomics to characterize the gut microbiome and metabolomes in 356 fecal samples of *Cercocebus agilis*, *Gorilla beringei*, *Gorilla gorilla*, *Pan troglodytes schweinfurthii* and *Homo sapiens*. Our results show that the diet-microbe co-metabolic landscape of wild primates converges with that of humans when foraging is focused on increased energy harvest; specifically, as far as predominance of microbes and metabolites involved in simple sugar processing and lipid turnover. As such, we present evidence that primitive dietary shifts to foods with high contents of readily usable energy not only prompted the acquisition of specific morphological and anatomical adaptations in human ancestors, but also of a colonic micro-ecosystem with increased capacity to harvest energy from food. Accordingly, these results offer a novel perspective on the ecological and dietary triggers behind the origin of early humans, suggesting that specific gut microbiome arrangements contributed significantly to this process. Additionally, we discuss how the detailed characterization of diet-microbe interactions in human extant relatives sheds light

on the evolutionary baseline of modern human disease.

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### Admixture Mapping of Coronary Artery Calcification in the NHLBI Family Heart Study (FamHS)

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Coronary artery calcification (CAC) is an important measure of subclinical coronary atherosclerosis, and is differently prevalent and severe in African Americans and European Americans. In general, CAC is less frequent and less severe in African Americans than in European Americans, despite African Americans having similar or increased exposures to coronary heart disease risk factors. Because CAC is differently prevalent in human ethnic groups, admixture mapping is a useful approach to identify genetic loci associated with this trait. Here, admixture mapping was used in the African American cohort of the Family Heart Study to identify genetic regions that are associated with CAC. The results show one genome-wide significant region on chromosome 12 and three potential regions on chromosomes 6, 15, and 19. Follow-up studies using data from previously reported genome-wide association meta-analyses, suggests that the regions identified on chromosome 6 and 15 contain variants that are possibly associated with CAC. The associated region on chromosome 6 contains the gene for BMP-6, which is expressed in vascular calcific lesions. Our results suggest that admixture mapping can be a useful hypothesis-generating tool to identify genomic regions that contribute to complex diseases, like cardiovascular disease.

### Secular changes in height among Polish schoolchildren within the socio-economic context: during the communism, political transition and capitalism, 1966-2012

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Secular trends in body size are related to improving environmental conditions. Poland, as one of the post-communist countries, was under the influence of different historical circumstances. Therefore, the aim of this study was to assess secular trend in height among Polish schoolchildren within socioeconomic stratification during last 50 years, throughout vast economic and political changes.

Four cross-sectional surveys were conducted in 1966, 1978, 1988 and 2012 in Poland, where 69,746 children aged 7-18 were investigated. Data for height were converted to Z-scores using LMS parameters for CDC 2002 year cohort. Socioeconomic variables include level of urbanization and parental education. Multifactorial ANOVA was run.

Significant trend in height between 1966-2012 was observed. Urbanization, education and their interactions with the year of survey significantly affected height. Between 1966-1988 the shortest and the tallest children were from villages and cities, respectively ( $p < 0.01$ ). However, in 2012 these differences diminished ( $p > 0.05$ ). Between 1966-2012 the shortest and the tallest was offspring of parents with elementary and university education, respectively ( $p < 0.05$ ). In 2012 these discrepancies decreased ( $p > 0.05$ ), except for elementary education of parents in boys and university education of mothers in girls. The highest size effect was observed for the year of survey, and then in the following order: urbanization, mother education and father education.

This study reveals the most complete analysis of the secular changes in height among Polish schoolchildren of both sexes between 1966-2012, within historical context, particularly presenting the biological effects of sociopolitical transformation on human growth.

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### Intraspecific Semicircular Canal Variance—A Missing Element in Adaptive Scenarios?

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The relationship between semicircular canal radius of curvature and orthogonality has been compared among primates with differing locomotor behaviors, the findings relying on one or a few individuals per species. A recent study of xenarthrans suggests that there is added adaptive information in the variability of functionally relevant canal measurements, with less variation found in more agile species (anteaters and armadillos) than in slow moving ones (sloths). If so, adult intraspecific variation may itself be evidence for varying levels of selection related to agility—there being less selective pressure to conserve a strict functional morphological state in a slow moving species than in a more agile one.

An analysis of intraspecific variation was conducted on two similarly-sized strepsirrhines, *Galago senegalensis*, an agile leaping species,

and *Nycticebus coucang*, a slow-moving one. The xenarthran findings predict that *Galago* should have less variability and *Nycticebus* more. We used 10 individuals per species and measured two functional parameters, radius of curvature (R) and canal orthogonality. We used Levene's test to assess the equality of variance for the two groups. We find no significant difference in variance of R between the two species. However, as with the xenarthran data, the agile leaping *G. senegalensis* exhibits significantly lower levels of variation than the slow moving *N. coucang* in the angle between the anterior and posterior canals and between the horizontal and posterior canals ( $p < 0.05$ ).

From the above, we find support for the hypothesis that, as with xenarthrans, variance in orthogonality is related to locomotor agility.

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#### Undergraduate Myth Busters: Records vs Reality of Osteological Materials

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Human skeletal remains, in both private and public collections, may have poor documentation, if any. We report on two such instances: a complete skeleton in a museum collection and skull in private ownership. The skeleton's documentation states: "a thin, pale female. Good bone structure and posture". The well-preserved skull reportedly belonged to "Ping Ping", a Chinese man who lived in Key West (KW) around 1900. Anthropometric and visual methods were used to assess osteometric dimensions of sex and ancestry for both. Results of the assessments were used to test the oral and written stories for each. Eight of 16 variables on the skeleton were in the male range, 5 were female, and 3 were ambiguous. Analysis of the KW skull showed that it was indeed a male with Asian ancestral affinities. We noted also that the skull was in outstanding condition, and was hemisected with modern side hinges and retaining springs on the mandible. We conclude that the skeleton was not female, but likely a gracile male, based especially on pelvic traits. We conclude that the KW skull is an Asian male. Its condition, along with the hardware strongly suggests it was sourced from commercially prepared teaching material. In both cases, the application of basic osteological assessment methods showed that the identity information for both were accession "myths" which were not supported by the data. We hope that examination of comparable materials in the future may help shed light on the reality of poorly documented osteological materials.

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#### Ring-tailed lemurs (*Lemur catta*) in small forest fragments: Which variables are the best predictors of population viability and juvenile recruitment?

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Primates worldwide are increasingly restricted to fragmented habitats surrounded by anthropogenic landscapes (grasslands, villages, crops). Variables important to primate population viability in fragments include dietary and behavioral plasticity, flexible home range size, and capacity to utilize matrix habitat surrounding the fragment. Due to massive deforestation, forest cover in south-central Madagascar has been reduced to small fragments dotting the landscape. Populations of *Lemur catta* persist in some of these fragments. Our aim was to evaluate potential for *L. catta* population viability in 9 fragments of varying sizes (2-46ha) in this region using comparative ecological measures. We used log linear models to examine effects of fragment size, within-fragment food tree density, and number of food resources in surrounding matrices on *L. catta* population size and juvenile recruitment. We found significant associations between total population size and fragment size, food tree density along transects, and number of matrix resources within 200 meters of fragment edges. Juvenile recruitment was positively correlated with fragment size and within-fragment food tree density, but not matrix resources. While these results are useful for predicting population viability, two additional variables: 1) degree of human disturbance within fragments, and 2) potential for male dispersal to other *L. catta* populations, play an equally important role in the likelihood of population persistence of ring-tailed lemurs in such fragmented habitat. While 7/9 fragments in our study were reasonably well protected from human disturbance, only 3 offered realistic potential for male dispersal, thus the long-term survival of most of these populations is highly uncertain.

#### Did an increase in body size play a role in the origin of *Homo*?

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Body size directly influences an animal's place in the natural world, including its energy requirements, home range size, relative brain size, locomotion, diet, life history and other aspects of behavior. Thus, an informed understanding of the biology of extinct organisms, including species in our own lineage, requires accurate estimates of body size. Since the last major review of hominin body size based on postcranial morphology over 20 years ago, new fossils have been discovered, species attributions have been clarified, and methods have improved. Here, we reevaluate individual fossil hominin body mass estimates based on a large sample of modern humans ( $n=220$ ) and common chimpanzee ( $n=25$ ) of known body masses; our human sample included many small-bodied people. We also present species and sex-specific averages based on fossils with reliable taxonomic attributions. Our results show that early hominins were generally smaller bodied than previously thought. This outcome is due in part to estimates in earlier studies deriving from larger bodied modern human reference samples. Our analyses show that modern human-like large size first appears 3-3.5 Ma in individuals of *Australopithecus afarensis*. There is little reliable evidence that body size of pre-*erectus Homo* differed from that of some australopiths, and the pattern of hominin body size evolution appears more complex than previously thought. Our results challenge what we thought we knew about hominin body size evolution and suggest the origins of *Homo* did not coincide with, and thus presumably were not driven by, an increase in body mass.

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#### Preparing calcined bone for strontium isotope analyses: A modification to standard methods

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The potential for reconstructing the geographic origins of burned skeletal remains with strontium isotope ratio ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) analyses has been largely ignored even though Grupe and Hummel (1991) and Harbeck et al. (2011) showed that strontium isotope ratios do not fractionate in bone and enamel specimens exposed to increasing temperatures. Current methods to prepare bone specimens for strontium isotope analysis include steps to fragment/powder and ash bone to remove organic components. These steps are likely superfluous for calcined bone already exhibiting both fragmentation and the absence of



## AAPA Abstracts

organic components. It is hypothesized that the processing steps associated with fragmentation and removal of organic components can be omitted when preparing calcined bone specimens; saving time and reducing possible contamination during sample preparation. This preliminary study examines a modification to traditional methods of sample preparation prior to chemical dissolution to assess calcined bone specimens. Five sets of calcined bone samples from faunal remains (*Felis catus*) of three separate individuals (N=15) were processed in preparation for strontium isotope analysis by Thermal Ionization Mass Spectrometry with variation of the omission of one or more of the following standard steps: bleaching, ashing, and powdering. Results indicate complete chemical dissolution of calcined skeletal samples weighing less than one gram with the omission of bleaching, ashing, and powdering during sample preparation.

**Kinetics of below branch quadrupedal walking in primates and other mammals: implications for the evolution of specialized suspensory locomotion**

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It has been suggested that the evolution of bimanual locomotion in primates was preceded by a shift to below-branch quadrupedalism for purposes of feeding and balance, yet little is known about the mechanics of limb use during below-branch walking. Recent studies in primates have demonstrated an increased reliance on the forelimb for support and propulsion during below-branch compared to above-branch quadrupedalism, but it remains unclear whether similar biomechanical patterns exist for all mammals that walk below branches or whether non-primate species adopt differing strategies. This study examines the kinetics of below-branch quadrupedalism in *Varecia variegata*, *Propithecus coquereli*, *Lemur catta*, *Daubentonia madagascariensis*, *Pteropus vampyrus*, and *Choloepus hoffmanni*. Animals walked below an instrumented arboreal runway, and values for peak vertical, braking, and propulsive forces as well fore-aft impulses were collected from each limb.

All primates sampled displayed a consistent limb-loading pattern in which both the peak propulsive and vertical forces were greater in the forelimbs (FL Ppk = 22.5% bw; FL Vpk = 81.1% bw) than the hindlimbs. Additionally, the forelimbs served a net propulsive role (0.023 bws), while the hindlimbs served in a braking capacity (-0.021 bws). Conversely, bats and sloths displayed little differences in loading between the forelimbs and hindlimbs. Bimanual locomotion is unique to Primates, and involves, by definition, a dominant role of the forelimb. Forelimb dominance during below-branch quadrupedalism may represent a significant

change that enabled a shift to the use of forelimbs in tension, and the evolution of bimanual locomotion in Primates, but not in other mammals.

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**Cultural meaning, social structure, and the health effects of systemic racism: The HEAT Heart Health study**

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Racial inequalities in health pose a crucial challenge to anthropological perspectives on race. For more than half a century, anthropologists have argued that race is not a valid framework for understanding human biology. Yet biomedical researchers continue to invoke race as a proxy for human genetic variation, and the persistence of racial inequalities in biological outcomes—from pregnancy to premature death—seems to confirm the intrinsic relevance of race to human biology. In the face of these trends, it is insufficient to assert that race is not biology. The challenge, instead, is (a) to test specific hypotheses about the presumed genetic basis of racial inequalities in health and (b) to examine the biological consequences of systemic racism.

Here we focus on two novel approaches to the measurement of systemic racism in HEAT Heart Health, a community-based participatory research study in Tallahassee, FL. First, we report on a culturally weighted measure of discrimination that links ethnographic (n=21) and survey (n=178) data among African American adults. The culturally weighted measure of discrimination is positively associated with depressive symptoms (b=0.227, p=0.010), independent of standard covariates. Second, we use social network analysis to assess individual exposure to structures of racial inequality. Personal networks confirm a high level of race-based segregation and substantial exposure to vicarious racism, such that self-reported experiences of discrimination underestimate exposure to systemic racism. Integrating ethnographic, network, and survey data provides new opportunities for examining the sociocultural context of health inequalities.

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**Synchrotron x-ray imaging and MCMC support seasonal climate reconstruction**

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We here present a synchrotron x-ray and Markov chain Monte Carlo (MCMC) model for reconstructing seasonal climate patterns from light stable isotopes in teeth. Seasonal rainfall and resource availability are thought to have influenced Plio-Pleistocene stone tool use, but ancient seasonality reconstructions face multiple challenges, including incomplete knowledge of tooth formation.

Fossil ungulate teeth are commonly associated with human ancestral remains. Here, we develop a quantitative, empirical molar mineralization model in domesticated sheep, similar dentally to other artiodactyls. Using molar teeth from 50 sheep, who died between the ages of 0-75 weeks at Cornell University, we create digital 3-dimensional models of lower first molars using synchrotron x-rays in Grenoble, France. We digitally extract developing enamel crowns, resample them to make each comparable, and convert x-ray data to mineral density. We then employ a MCMC method using python script to estimate most likely mineralization trajectories at over 50,000 tooth crown locations.

The model shows mineralization in two discrete waves over a 90-120 day period, resolving discrepancies between past theories of tooth growth. We combine our model with blood isotope and mineral turnover models that we test empirically using live sheep, to quantitatively predict tooth isotope ratios from climatic or behavioral patterns. Lastly, we employ a second MCMC method to estimate most likely rainfall patterns given isotope sampling from fossil teeth. Combined with further work in isotope paleoecology, this method has great promise to help resolve how seasonal climatic patterns interacted with early human evolution and behavior.

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**Unexpected results from the ventral side of the hominoid scapula**

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Most landmark-based studies of the scapula consider dorsal blade characteristics, like spine orientation. Given its variability among hominoids, spine orientation predominates examinations of scapular morphology, likely obscuring important aspects of overall blade shape. As such, we investigated hominoid scapular morphology using two geometric morphometric (GM) approaches – one employing six homologous landmarks (including spinal points) and another with 98 sliding semilandmarks along the boundary of the subscapularis fossa.

As anticipated, the GM analysis using static landmarks principally sorted groups by spine orientation: *Homo* and *Hylobates* scapulae were at opposite morphological extremes with transversely- and obliquely-oriented spines, respectively; African apes and *Pongo* were intermediate. The semilandmark approach, which did not account for spine orientation, yielded vastly different results. *Homo* and *Gorilla* clustered together with superoinferiorly broad and mediolaterally compressed blades. *Pan* was similar, but with more laterally-positioned superior angles. *Hylobates* was superoinferiorly narrow, yet obliquely expanded relative to the vertebral border. *Pongo* scapulae were unique among hominoids in being nearly as broad as they were long.

In this context, previously documented ‘convergence’ of *Homo* and *Pongo* scapulae appears to be principally driven by similarities in spine orientation, rather than overall blade shape. Furthermore, these results support gorilla-like characterizations of fossil hominin scapulae. It is thus parsimonious to hypothesize that the scapula of the African ape/*Homo* last common ancestor was comparable to *Gorilla*. Accordingly, the evolution of *Pan* (highly oblique spine and laterally-situated superior angle) and *Homo* (transversely-oriented spine) scapular morphology involved relatively minor shifts from this ancestral condition.

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#### **Apotropaics and the undead: A biogeochemical assessment of vampire burials in post-medieval Poland**

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Apotropaic traditions, including objects placed with the dead as a means of protection against evil spirits, were employed throughout Eastern Europe during the post-medieval period in order to prevent the dead from returning as vampires. Among the hundreds of normative burials excavated thus far at the rural cemetery of Drawsko I (17<sup>th</sup>-18<sup>th</sup> c. AD) in Poland, six deviant interments have been interpreted as individuals considered at risk for vampirism because of apotropaics accompanying their bodies. In particular, those marginalized in life for having an unusual physical appearance, perishing first during an epidemic, committing suicide, or being an outsider to the community were traditionally thought to be more susceptible to vampirism.

This study explored whether social differences between individuals interred in standard and deviant burials might be identified by isotopic analysis. We hypothesized that those targeted for apotropaic mortuary rites at Drawsko were non-locals due to their status as ‘outsiders’ during a time of influx of immigrants from across Europe into Poland, and tested this hypothesis using radiogenic strontium isotope ratios from dental enamel. Instead, <sup>87</sup>Sr/<sup>86</sup>Sr values (0.7112 ± 0.0006, 1σ; n=60) suggested that most (n=57) were local to Drawsko, including all those marked by apotropaics as potential vampires. Subsequently, these individuals were not interred in this manner due to a non-local identity, but instead, were distrusted within some other societal context as members of the local community. Cholera outbreaks during the post-medieval period throughout Poland may offer an alternate explanation to these mortuary customs.

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#### **Different Perspectives on the Expression of Joint Kinematics Can Influence Interpretation of Fossil Evidence**

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Exploration of joint kinematics has a long history in anthropological literature. These data are often used to form inferences concerning early hominine functional patterns. Clinical kinematic data capture has become increasingly sophisticated and can now describe multiple joint rotations about obliquely oriented axes. This increased sophistication comes at the cost of data collection that is mathematically complicated and extremely sensitive to differing reference frame orientations. Primate kinematic studies have tended to lag in the technical and

mathematical sophistication of their data capture methods. As a result, it can be difficult to draw simple comparisons between human and non-human kinematic data. This presentation provides an example of this complexity and its effects on data interpretation.

Inman's (1976) description of the human subtalar joint serves as an example. The “average” joint rotates 24° about an axis oriented 42° from the horizontal and -23° from the midline. This single joint rotation produces the appearance of -9.3° plantarflexion/dorsiflexion, 15.9° inversion/eversion, and 14.1° abduction-adduction. This perspective yields a tri-planar motion that would seem inconsistent with Inman's original description. Further, a simplistic lateral view 2D data capture provides the appearance of -5.0° rotation within the sagittal plane. Thus, we have three very different descriptions of a joint's kinematics that all describe the same phenomenon. Through this example we demonstrate that different methodologies yield non-comparable results. When humans and non-humans are evaluated separately, uninformed comparisons can sometimes be unintentionally misleading. Inferences on early hominine function should be drawn from equally sophisticated kinematic studies that use identical methods.

#### **Decoration and cremation of Neolithic human bones from Göbekli Tepe, Turkey**

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Within the last three years excavation at Göbekli Tepe, the earliest known temple complex, located in East Turkey, revealed quite a lot human bone fragments from the filling of the buildings. Except one slightly better preserved skeleton, 594 single fragments have been investigated by macroscopic, radiological, scanning electron microscopical and histological methods. The most frequent type is skull fragments (349) followed by long bone fragments of the lower extremity (111) The amount of fragments is decreasing from the upper extremity (52) to foot, hand and fragments of spine, ribs and pelvis. This indicates that whole bodies were buried, and not only a selection of long bones and skulls were placed in the area. Several kinds of artificial treatment show specific burial customs: Signs of burning or impact of low heat were present in 109/594 of the fragments, 19/594 showed cut marks most probably due to dismembering. On skull fragments of three different individuals up to 3mm deep straight geometrically carved decorations are placed mostly in the frontal and anterior parietal parts of the skull. The carvings on the best preserved skull are extending in a sagittal line to the occipital and also to the mandible. In contrast to all other fragments, in this special case a drilling on the left parietal was done and remnants of ochre were visible. These

different burial customs will be discussed in comparison to other sites in Neolithic Turkey and an overview about age and sex distribution as well as pathological processes will be given.

**Ontogenetic morphology of the cervical vertebral column in *Homo sapiens* with implications for *Australopithecus afarensis***

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Comparative studies have illuminated functional aspects of the cervical vertebral column in primates. An ontogenetic perspective of the functional morphology of the neck is absent from the literature. Recent discovery of an immature fragment of an australopithecine cervical vertebra (A.L. 444-9) allows the investigation into the evolutionary ontogeny of the hominin cervical spine. Quantifying the changes in morphology through growth allows us to better recognize how adult morphology is formed. It also presents possible medical applications through the understanding of the biomechanics of an immature neck. For this research, morphometric measurements, correlated with neck posture and attainable from the fossil specimen, were collected from human individuals (n=12) with estimated ages in archaeological populations.

Results show age-related changes in size and robusticity of the lamina but relative stability in angular orientation of the articular facets. Within the medical literature the infant human neck is known to be particularly prone to injury. The maturation of articular facet orientation at a young age suggests that the instability of the infant neck has little to do with the zygapophyseal joint, and may indicate stringent genetic control of this morphology. In this aspect, it is possible to understand adult morphology even in juvenile specimens. The immature *A. afarensis* fragment possesses a morphology similar to that found in the human cervical spine. This implies postural similarities between *H. sapiens* and australopithecines.

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**Rejection of one-time and fixed-rate admixture models in African Americans**

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Genetic studies have improved our understanding of African American admixture

history, but, to date, none have examined how social changes have affected the dynamics of the process. Our goal is to use genotypic data to detect changes in African American admixture dynamics, and investigate how these changes relate to shifts in social conventions.

Our data are 1,022,144 SNPs common to 112 Yoruban (YRI), 110 CEPH European (CEU), and 82 African American (ASW) unrelated individuals from HapMap Phase III. We use the expectation maximization algorithm implemented in LAMP to estimate individual-level African and European ancestry proportions on the autosomes and the X-chromosome. We assess sex-bias and compare the variance in autosomal African ancestry among individuals to that predicted under two models of admixture history: a one-time admixture model, and a model with a fixed rate of gene flow from both parental groups.

The average African ancestry estimate on the X-chromosome is 82.4% (range: 39.3% to 100%). This estimate is high relative to the autosomal average of 78.2% (range: 56.2% and 95.6%), and consistent with previous findings of a sex-bias with greater contribution by European males than females. An F-test shows that the variance in autosomal African ancestry proportions among individuals is significantly greater ( $p < 0.0001$ ) than that expected under the one-time and continuous admixture models, suggesting that changes occurred in the rate of admixture over the course of African American history. We explore the connections between models that incorporate varying rates of African and European contributions and our social history.

**Venom usage, anti-predatory chemical behaviors, and responses to predators among slow lorises (*Nycticebus spp.*)**

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Predation is a critical factor driving the evolution of primate behavior and sociality, but less attention is given to physiological responses to predation. Although most studies of the defensive responses of nocturnal primates focus on cryptic behaviors, it has been suggested that slow lorises (*Nycticebus spp.*) produce toxic compounds as a means to deter potential predators. These toxins exist in conjunction with a suite of physical characteristics that mimic serpentine appearance, movements, and vocalizations. This study tested the hypothesis that venom production and behavior in slow lorises are part of an antipredator strategy. Here we present data that slow lorises use chemical signaling as a direct response to predator stimuli.

From January to June 2014, we observed wild Javan slow lorises (*N. javanicus*; n=8) and wild-caught Sumatran slow lorises (*N. coucang*; n=10) in Java, Indonesia. We conducted playback experiments using recordings of natural predators, and tests where individuals were exposed to olfactory cues from the same predators. For both types of tests, lorises engaged in venom-related behaviors (gland licking, anointing, self grooming, tongue flicking) more frequently after exposure to the treatment. Slow lorises engaged in chemical behaviors in response to auditory and olfactory predator stimuli, indicating that the production of toxic compounds relates, in part, to predator defense. Results suggest that predation pressure is one factor driving the evolution of the unusual phenotypic characteristics seen in slow lorises, where the toxic compounds they produce function as part of a chemical defense system.

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**Preliminary osteological analyses of the early Medieval Prussian population at Beżawki, Poland**

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The early Medieval (XIII c.) cemetery site at Beżawki, Poland has seen renewed interest in recent years due, in part, to the unique nature of the burial site and skeletal population. As one of the few remaining well-preserved Old Prussian cemeteries, the Beżawki site holds a wealth of information allowing investigation into the activities, pathologies, and characteristics of the region and period. While archaeological data for the site, including burial rituals and logistics, have been well documented and continue to expand, the systematic detailed analysis of osteological data is just beginning. During the 2014 field season, which ran in conjunction with the Beżawki Field School, a portion of the skeletal population (n=59) was analyzed to establish general population demographics and survey pathology and traumata. Preliminary results indicate that the examined portion of the Beżawki population contained at least 14 infants, 13 children, 6 adolescents, and 23 adults. The preliminary sex distribution was approximately equal between males and females, with a possible pattern of slightly younger males and older females. While stature estimates were within the range of contemporary populations, additional research is necessary to establish a statistically reliable, population specific regression for Beżawki individuals. The

dentition of most individuals displayed evidence of metabolic stress events and minor to severe dental attrition and calculus. Individuals, both male and female, were generally robust with increasing signs of osteoarthritis with age. Future field seasons will focus on a more in-depth analysis of pathology and trauma while continuing to expand the data set.

#### Old Boys Club Starts Early: A Network Analysis of Peer Perception in Undergraduate Classrooms

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Gender gaps in STEM disciplines are a major concern, and exist across several facets in academia. However, research on gender gaps tends to focus on the impacts of biased faculty perceptions and often excludes fields where females are the numerical majority. We test for gender inequalities in students' perception of their peers' grasp of the course material at the undergraduate level across several introductory biology classes. Female students make up the majority of these classes, similar to most anthropology classrooms. Repetition of this experiment is currently underway within a biological anthropology classroom.

Our analyses within biology show that gender matters. Using network analyses and logistic regression models, we find males are more likely to become particularly well known within a class, largely due to males under nominating their female peers as knowledgeable. Combining this network data with data within the same classrooms on self-reported confidence, participation patterns, and student achievement, we propose a mechanistic model by which student self-perception in a classroom can result in lowered peer perception, and potentially lowered persistence within STEM. This model helps inform instructional strategies to bring more equality to the classroom.

#### Variation in primate enamel formation front angles

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Recent studies of enamel formation in non-human primates (cebids and hominoids) have analyzed enamel formation front (EFF) angle variation across taxa for their potential role in systematic analyses as well as for their potential relationship to variation in life history or related

variables. These angles are measured along striae of Retzius, which represent the EFF at a given point in time. Although often referred to as "proxy" measures for rates of enamel extension, these angles are also related to the angles that enamel prisms make with the enamel-dentine junction and to daily secretion rates. This study analyzes taxonomic patterns of EFF angle change along the EDJ and the relationship between EFF angle variation and seven life history or life history-related variables across a broad taxonomic spectrum. Sets of anterior (n=55, primarily catarrhine) and posterior (n=22, platyrrhine and strepsirrhine) teeth were analyzed separately. Repeated measures analyses of patterns of EFF angle change along the enamel-dentine junction from cusp to cervix indicate clade differences but also significant within-clade variation. Bonferroni-corrected phylogenetically controlled regressions performed for seven variables tested for relationships to EFF angles revealed a statistically significant positive relationship only for weaning age. Although additional testing is ongoing, these results indicate that: (1) there is substantial overlap in patterns of EFF angle change among major clades, suggesting caution in their use in systematic analyses and (2) the relationship between variation in these angles and life history or related variables is a weak one, the reasons for which will be explored.

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#### Examining the co-evolution of primates and angiosperms: Brazzein sweet proteins and gorilla taste receptors

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In mammals, G protein-coupled receptors on the tongue facilitate the perception of sweet taste. Although sweet taste normally functions to signal high energy content, several plants produce low-calorie proteins that also bind to sweet taste receptors, likely as a strategy to 'trick' animals into eating these low-energy fruits and dispersing the seeds. For example, brazzein, a protein produced by the West African plant *Pentadiplandra brazzeana*, binds to human sweet taste receptors, mimicking the taste of sugar. However, variation in the genes *TIR2* and *TIR3*, which encode the sweet taste receptors, contributes to variation in the ability to taste various sweet molecules. Mice, for instance, exhibit several amino acid substitutions in the cysteine-rich region of *TIR3* that prevent brazzein binding. We examined *TIR3* sequence

variation in primates and found that western gorillas (*Gorilla gorilla gorilla*) possess amino acid substitutions at three of the same amino acid positions, suggesting that they also do not taste sweet proteins as sweet. Because the distribution of western gorillas overlaps with that of *Pentadiplandra brazzeana*, evolution of *TIR3* on the western gorilla lineage may have offered a way to avoid the plant's false signal of energy content. To see whether eastern gorillas, which purportedly do not come into contact with brazzein, likely taste the protein as sweet, we also sequenced the relevant region of *TIR3* in multiple eastern lowland gorillas (*Gorilla beringei graueri*). We found that the gorilla sequences are identical, suggesting that these changes in *TIR3* occurred before the divergence between gorilla species.

#### Fossil tarsiiforms: a tangled tree

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Fossil tarsiiforms ( $\approx$  Omomyidae) first appear as single, separate, essentially temporally co-occurring, species of *Teilhardina* on the northern continents in the earliest Eocene (~56 Ma). Initial radiation is followed by rapid diversification and dispersion reaching its zenith in the late early through middle Eocene, especially in North America and Europe. The group essentially disappears from the fossil record by the end of the early Oligocene, probably in conjunction with globally cooling temperatures that commence near the Eocene-Oligocene boundary (~34 Ma). The taxonomic history of the group is byzantine and centers on its potential relationships with extant *Tarsius* and related forms. Omomyidae has been variously viewed in the past as sister group to living tarsiers, as sister group to other Euprimates to the exclusion of tarsiers, or as having tarsiers nested within Omomyidae. In the latter case, various omomyid genera have been proposed as close/closest relatives of the living tarsiers depending upon which anatomical system is given the most weight in cladistic analyses. Recently described forms such as *Archicebus* from China have helped to clarify within-clade taxonomy but still have not addressed ultimate relationships of the group as a whole. Re-study of the iconic skull of *Rooneyia*, a potential stem haplorhine/basal anthropoid from Texas, utilizing micro-ct technology has revealed that most of its cranial anatomy is inconsistent with it being either a strepsirrhine or a basal haplorhine. Many puzzles remain – more fossil data doesn't necessarily lead to more clarity given that most taxa are still represented by dentitions alone.



### Pelage Coloration as an Adaptive Trait

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Pelage coloration is a morphological feature often used in taxonomic classifications. This is somewhat surprising given that color designations are often very subjective and qualitative. Nocturnal primate species are often thought to be dark colored and any variation in their pelage patterns are generally considered inconsequential. However, variation in pelage coloration in nocturnal primate species may represent an ecological adaptation. The goal of this paper is to determine whether fur coloration in spectral tarsiers is an adaptive characteristic. Forests are known to vary in both their structure as well as their coloration. This research was conducted at Tangkoko Nature Reserve in Sulawesi, Indonesia from January through April 2013. Fur color was determined in 20 spectral tarsier adults. Color was graded using Munsell's Soil Color book. Tree bark coloration was also determined at breast height for all trees within the 20x20 m vegetation plot as well as for the sleeping site. The results of this study indicate that there is remarkable similarity between the average fur color of this tarsier population and the average bark color of the trees used by the tarsiers. Clearly, more quantitative studies of pelage need to be conducted to evaluate intraspecific and interspecific population variation, to evaluate whether other species fur coloration is a form of camouflage, as well as exploring and refining new methods to quantify pelage variation.

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### The vertebral column and thorax in the Middle Pleistocene: the case of the Sima de los Huesos

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Recent studies have demonstrated significant morphological and postural differences when the Neandertal vertebral column (VC) and thorax (TH) are compared to modern humans. The

Middle Pleistocene VC and TH record in Europe is basically restricted to the site of the Sima de los Huesos (Sierra de Atapuerca, Spain) and thus, its study can yield information on the evolution of these regions in the Neandertal clade.

The SH VC is morphologically different from both Neandertals and modern humans. The SH cervical spine shows an anteroposteriorly elongated vertebral canal in the atlas likely related to an elongated foramen magnum; a craniocaudally low and mediolaterally wide axis; anteroposteriorly long fifth cervicals and robust spinous processes of the sixth and seventh cervical vertebrae. The overall neck length is similar to Neandertals, and close to but slightly below the mean of recent humans. The SH lumbar spine displays a low degree of lordosis and long, dorsolaterally oriented transverse processes. The low lordosis appears to be a derived character shared with Neandertals.

Judging from the size of a complete first and an incomplete second rib as well as partial information from mid-thoracic elements, the SH hominins likely had large thoraces. The SH ribs also show marked insertions for the intercostal muscles, a characteristic also present in Neandertals as well as Upper Paleolithic modern humans.

In summary, the trunk elements from SH show a mosaic nature, with some metric dimensions likely reflecting their generally wide and large body bauplan.

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### Body Height of Mummified Pharaohs Supports Historical Suggestions of Sibling Marriages

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Body height is an important factor in reconstructing health conditions and it serves as an indicator of socio-economic status. Stature is considered to be determined heavily by heredity. To obtain evolutionary perspectives on human health and environmental factors one depends on reliable ancient data. Ancient Egypt usually serves as a model for ancient societies, as it provides mummified remains dated to several time periods. The aim of this study is to assess variations of ancient Egyptian royal body height

in terms of secular trends, sexual dimorphism, comparison with commoners, and indications of suggested inbreeding. This study presents body height estimates (a.o. CT data, length of femur and tibia) from all periods (N= 259, 116 females, 143 males) and compares the general population with the existing mummies of the members of royal families (N= 38, 22 males, 16 females). Royals were scored with respect to the level of consanguinity. Exemplary, the body height variation of the New Kingdom male royals (SD=4.87 cm; N= 22) is significantly reduced when compared to a pool of non-royal mummies (SD=7.27 cm; N=30; F-Snedecor test, p<0.05) providing indications for inbreeding. However, there appears to be no correlation between the level of inbreeding and individual body height. The random sample of general population does not show signs of inbreeding. With the present lack of larger, technically and ethically challenging genetic studies, the selected non-invasive approach of body height is the most reliable indicator of sibling-marriages of Pharaohs based on direct physical evidence.

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### 3D Scanning and Morphometric Analysis of the Tibia: Insights into Nubian Activity Patterns

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This paper examines differences in diaphyseal tibial shape between three assemblages of ancient human remains from northern Sudan. Athletics research in biomechanics demonstrates that the tibia responds to activity-related strain by increasing or decreasing periosteal bone, leading to differing diaphyseal shapes. Examining these differences in cortical shape over time for one geographic area can help identify local, regional, or pan-cultural activity-based social organization over the prehistory of the Upper Nile region, including shifts in subsistence strategy and changes brought about by contact with Egypt and the Sahel. It is commonly assumed that the larger urban cultures prevalent around 2000 BC were primarily agricultural, but the abundance of cattle in elite burials implies that part of the population were pastoralists, similar to other trans-Saharan cattle cultures. This may indicate a division of labor that can only be evidenced in tibial shape. Utilizing 3D laser scanning, six midshaft tibial shapes have been identified and subjected to biomechanical and morphometric data, each of which indicates the level and possibly type of activity of each individual. A divergence of tibial shape types between males and females suggest changing labor patterns between early and later periods alongside increased diversity of tibial shapes in the agricultural group, signifying a division of labor. This technique can evaluate the proportion of "professions", or shape types, per assemblage and track changes in Nubian subsistence strategy across time and can thus



bolster evidence for a suggested subsistence strategy in other Nubian groups.

**Testing competing ideas about the relationship between body shape and wellbeing using a global sample of infants and children**

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Anthropologists have long recognized that populations differ in their body type and shape. In the field of public health, bodies that are deemed 'too thin' or 'too large' are viewed as at risk of adverse health outcomes. Under this model, the relationship between body shape and ill health is considered invariant across populations. We propose an alternative, ecological model that considers population body shape to be comprised of a component reflecting well-established differences in population body shape – what we label basal weight for height – and a component reflecting excessive or insufficient energy stores. Only the latter component is predicted to pattern children's health. Using a sample of more than 500,000 children from 62 countries we show that 1) there is considerable between-population variation in basal weight for height, 2) that contrary to the invariant model, basal weight for height does not predict child illness but 3) individual deviations from a population's basal weight for height do. These results are consistent with other recent results in biological anthropology on population-variation. We conclude by discussing ongoing debates about the nature of population-level variation and the theoretical and applied implications of this variation.

**Hip joint osteoarthritis in the MLD 46 (*Australopithecus africanus*) proximal femur**

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Hip osteoarthritis is widespread in modern populations, but almost unknown in prehistoric humans outside of Europe and in non-human primates. Here, we report on the earliest case of hip osteoarthritis in a human ancestor, the 2.58 Ma old MLD 46 proximal femur (*Australopithecus africanus*) from Makapansgat, South Africa. It shows extensive marginal and medial osteophyte formation reflecting severe hip osteoarthritis. The ovaloid shape of the MLD 46 femoral head and the absent flattening is, however, not characteristic of the common aetiologies of hip osteoarthritis including primary hip joint osteoarthritis, femoroacetabular

impingement and developmental dysplasia of the hip. Our palaeopathological analysis rather suggests acetabular protrusion that most commonly is associated with rheumatoid arthritis and sickle-cell disease. The differential diagnosis is narrowed down by a Micro-CT analysis demonstrating the presence of a large sclerotic zone in the medial sector of the head. It most closely resembles the morphology of an osteonecrosis rather than a bone island or tumour metastasis. In modern tropical Africa, osteonecrosis is a common complication of sickle-cell disease and other haemoglobinopathies, whereas other aetiologies including corticosteroid medication and alcoholism can be excluded in *Australopithecus africanus*. If our interpretation were correct, it would suggest sickle-cell disease as the most plausible condition explaining both the acetabular protrusion and the osteonecrosis of the femoral head. Because sickle-cell disease offers protection against malaria, this might imply that the earliest human ancestors already evolved adaptations against *Plasmodium* infections. In addition, our results are important for the reconstruction of the palaeoenvironment at Makapansgat.

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**Female smoking prevalence and the fertility transition**

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Tobacco consumption is responsible for about 1 in 5 deaths in developed countries, and 1 in 10 deaths in developing countries. There is little difference in mean male smoking prevalence in developed vs. developing countries (30.1% vs. 32%, respectively). Female smoking prevalence, in contrast, differs dramatically (17.2% vs. 3.1%, respectively). This difference in female smoking prevalence is usually ascribed to differences in women's social and economic power in developed (high) vs. developing countries (low) and attendant norms regulating women's substance use.

Nicotine and other constituents of tobacco, however, are potent teratogens. Moreover, nicotine activates virtually all neurophysiological toxin defense mechanisms, such as bitter taste receptors, nuclear receptors, xenobiotic transporter and metabolizing proteins, and conditioned aversions. This raises the possibility that, to protect their fetuses and nursing infants, women with reduced access to modern methods of birth control, high fertility, and extended periods of breastfeeding, as is seen in many developing countries, avoid regular consumption of teratogenic substances like tobacco, compared to women in populations with low fertility, such as most developed countries.

To test the socioeconomic vs. fetal protection hypotheses of female smoking prevalence, we examined female smoking prevalence in 186 countries. We found that high total fertility rate, low use of modern birth control, and high breastfeeding at two years predicted low female smoking prevalence even after controlling for indices of women's social, economic, and educational status. We also found that, in developing countries, female smoking increased post-menopause. These results suggest that fetal protection helps explain female smoking decisions.

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**Abnormal healing of a femoral spiral fracture and its functionality in a Cypriot Geriatrician**

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While the study of exhumed burial remains from the St. Nicholas cemetery of Cyprus was undertaken by the 2014 field school held by Texas Tech University a very unusual fracture pattern to the left femur was identified in burial number 14. The purpose of this presentation is to share information specific to this unique fracture. In addition to this fracture, the individual showed numerous skeletal traumas including: a dislocated left shoulder joint, fractured radius, multiple blunt force traumas to the skull and an unhealed left III fracture of the splanocranium. Unique to this project, demographic records kept at the cemetery are available and the records show that the decedent lived to be 100 years old. Similar to most of the injuries seen on the individual, the break of the femoral neck from the shaft did not receive medical attention and the healing was not set in normal anatomical position. To accommodate continued use, skeletal features show that he developed a pseudo-joint replacing the hip joint by utilizing the posterior surface of the femoral head and the posterior surface of the lesser trochanter. Eburnation on both of these surfaces indicates that this pseudo-joint was functional. This paper will discuss the musculo-skeletal structures that have been affected by this modification and biomechanical functionality.

**Applications of medicinal plants in the treatment of psychological disorders**

ROBERT A. HALBERSTEIN. Anthropology and Nursing, University of Miami.

The application of medicinal plants in the treatment and prevention of diseases and injuries

is a cross-cultural practice that began in prehistory. Field research conducted in two Caribbean populations and in the Caribbean-American community of Miami, Florida that included interviews with 13 traditional healers and herbalists yielded information on nine plants utilized primarily for psychological treatments. Preparation methods, including decoction and infusion, permit the extraction and concentration of curative chemical components from selected plant parts while simultaneously neutralizing potentially harmful ingredients. Botanical products with sedative, hypnotic, tranquilizing, stimulating, hallucinatory and other mind-altering effects have been successfully applied in the treatment of epilepsy, depression, dementia, hyperactivity and additional debilitating mental disorders in these and other populations. While counseling and botanical remedies comprise the treatments of choice, the traditional healers refer patients to available biomedical resources in cases of severely incapacitating conditions. Several plant chemicals, including flavonoids, glycosides, hydrocarbons, triterpenes and alkaloids, have been shown to influence the metabolism and activity of enzymes and neurotransmitters with potentially antidepressant, energizing and other positive psychological effects. Four of the species encountered in the present study populations are also widely used for the same purposes in other locales—*Ginkgo biloba* as a cognitive enhancer, *Hypericum perforatum* (St. John's Wort) as an antidepressant, *Matricaria recutita* (Chamomile) as an anticonvulsant, and *Valeriana officinalis* (Valerian) as a sedative. Side effects have also been recorded for these herbal medicines, including blood pressure fluctuations, gastrointestinal irritation, sensory alterations, dizziness, fatigue and hypersensitivity to sunlight.

#### Investigating the variation at pterion across platyrrhines, with special attention to *Alouatta*

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*Alouatta* is the most variable platyrrhine in terms of which bones make contact at pterion. In Ashley-Montagu's (1933) sample, 55% show the "catarrhine" pattern of contact between the frontal and sphenoid rather than the zygomatic-parietal contact seen almost exclusively in other platyrrhines. Why? Ashley-Montagu suggested the small convergent orbits of catarrhines are the reason they have more room at pterion for the sphenoid to expand and contact the frontal. While this might explain the variation at pterion across anthropoids which differ in body size, and hence relative orbit size, what about within a single genus like *Alouatta*?

Ashley-Montagu's descriptions are reproduced here in a sample of 450 platyrrhine crania; *Alouatta* is the most variable, followed by *Ateles*.

*Alouatta* has narrow orbits for its cranial length but a wide interorbital distance, which is even wider in individuals with frontal-sphenoid contact. There is no significant difference in orbital aperture dimensions between *Alouatta* with frontal-sphenoid contact and those with zygomatic-parietal contact. Instead, the difference between the two groups is in overall cranial shape. The long unflexed cranial base of *A. seniculus* is associated with a wide sphenoid which often contacts the frontal, while the shorter more flexed condition seen in *A. palliata* corresponds with a higher percentage of zygomatic-parietal contact. Rather than taking up space vacated by convergent orbits, the sphenoid is the open hinge between the neurocranium and face which accommodates the enlarged hyoid bone. Further work is necessary to elucidate the specific biomechanical consequences of one sutural pattern or the other.

#### Bone collagen stable isotope analysis of three late Holocene humans from Interior Alaska

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Three prehistoric human skeletons were uncovered at the Tochak site near the inland Alaskan community of McGrath on the Upper Kuskokwim River. The skeletons include an adult male (35-40 years), a younger adult male (19-20 years) and a child (2-3 years). Direct radiocarbon dating suggests an age of 1,000 years cal. BP. Ethnohistorical reports suggest that the indigenous Athabascan people of this region were mainly hunters, rather than fishers, but paleodietary studies have never been conducted in interior Alaska. Carbon and nitrogen stable isotope analysis ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) was conducted on bone collagen from the humans, and on faunal remains from a younger-component (ca. 350 cal BP), including domestic dog, bear, beaver, and freshwater fish. For the humans,  $\delta^{15}\text{N}$  values are relatively high and remarkably similar (15.2-15.3‰). The  $\delta^{13}\text{C}$  values are also similar in the adult and subadult males (-18.8‰ and -18.4‰, respectively), but slightly lower in the child (-19.6‰). The human carbon and nitrogen isotope ratios are elevated over those of the prehistoric bear from the site, and are consistent with a diet that included a substantial proportion of marine-feeding animals, such as anadromous salmon found in interior Alaskan rivers. Two dog specimens from the younger component also show elevated  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values consistent with a salmon-rich diet. These results suggest that fish, including salmon, were a critical resource for late Holocene populations in west central Alaska, both for human consumption and for dog provisioning, and contradict historical accounts of a subsistence emphasis on terrestrial mammals.

#### Analyzing handedness using metacarpal cross-sectional geometry in archaic human populations

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Hand laterality, or the tendency of a population to use one hand over the other in a variety of actions, is a unique, panspecies trait in humans, argued to indicate a more profound structural asymmetry that extends to cerebral function. Previous investigations of morphological and biomechanical asymmetries demonstrate that humans show a strong right-hand bias and greater overall asymmetry in the upper limb, including in the hands themselves. In pre-industrial populations especially, males tend to exhibit greater asymmetry. However, studies of the laterality of hand bones themselves have been primarily limited to the second metacarpal. This study evaluated directional bilateral asymmetry of the hand using the second through fifth metacarpals. These were measured from a sample of 50 adult male and female skeletons from Middle and Late Archaic forager groups excavated from three sites in western central Tennessee. Cross-sectional properties obtained for these individuals were analyzed for magnitude and direction of asymmetry—given by percent directional asymmetry (%DA) and percent absolute asymmetry (%AA)—as well as for the overall shape of the cross-section. Although nonparametric statistical comparisons of asymmetry between the sexes and among metacarpals did not produce significant *p*-values (*p* < 0.01), the trends of increasing asymmetry in the medial palm caution against using the cross-sectional properties of a single metacarpal to estimate those of the rest. This study highlights the need for further research in this area to establish and understand not only the patterns of asymmetry across the metacarpals, but also the activities that engender them.

#### Evidence of Fluvial Transport of Human Skeletal Remains at Actun Tunichil Muknal, Belize

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Actun Tunichil Muknal (ATM) is a unique cave in central Belize, which when discovered in 1986 was completely undisturbed by humans. Prior research conducted in the cave included a GIS spatial analysis and anthropological survey of the human remains. Interpretations of artifact and bone distributions in ATM have presumed that the Mayans had deliberately placed the items in the positions that they currently occupy. However, one confounding problem is the sometimes substantial seasonal flooding of the

cave. Therefore, this taphonomic analysis aims to determine whether the bones have been moved and sorted by fluvial transport and whether previous interpretations of cultural activities in ATM must be modified.

This study documents the distribution, orientations, and condition of the human bones in relation to artifacts and cave features associated with water movement. Most bones are no longer in anatomically-meaningful positions and are located in spots where they would be deposited by flowing water and gravity. Bones are not clustered with artifacts, suggesting hydrologic sorting. In particular, infant remains are washed into lower reaches of the cave and may have transported as bundles. In summary, it is likely that many of the bones have moved to their current locations via fluvial transport and thus any interpretations of Mayan burial rituals must be tempered by a reference to non-cultural taphonomic forces.

#### **Chimpanzees (*P.t. verus*) change the landscape of a forest fragment by dispersing cultivars raided from local villages**

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Chimpanzees (*Pan troglodytes verus*) living in a forest fragment in the Tonkolili District of Sierra Leone exploit their anthropogenic habitat by raiding crops of the surrounding human communities. Over a three year period, we have documented – through observation, fecal analysis, and community reports – chimpanzees consuming cultivars such as mango (*Mangifera indica*), oil palm (*Elaeis guineensis*), groundnut (*Arachis hypogaea*), and guava (*Psidium guajava*). Local villages report chimpanzees taking cultivars from crop fields and bringing them into the forest. We therefore hypothesized that the chimpanzees disperse the seeds of these cultivars into the forest.

We sampled a 3 km<sup>2</sup> plot within a forest fragment bordered by cultivated crop fields, and recorded the presence of each cultivar within the plot. In order to determine a possible animal dispersal vector, we discarded samples that fell within a 15 meter radius of a fruiting tree. Of the remaining seedlings (n=72), 71% fell within 2 meters of a chimpanzee created path or nest. Of these, the cultivars we recorded consisted of mango (69%), guava (17%), and groundnut (4%). Though there are other possible seed dispersers (humans, monkeys, other mammals, etc.), due to the proximity of these seedlings to chimpanzee trails and nests, along with community reports of chimpanzees transporting

these crops into the forest and reports of local monkey populations only raiding unripe fruits, we conclude that chimpanzees are likely vectors of cultivar dispersal. Such results provide insights into the ecology of a chimpanzee habitat at the human-primate interface.

#### **The Case for Uncertainty: Quantifying Isotopic Uncertainty with Bayesian Mixing Models**

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Quantifying uncertainty in isotopic data is notoriously difficult and often overlooked. This is particularly true for questions not easily addressed using standard hypotheses tests, like member-of-a-class or source contribution questions. Bayesian mixing models provide a rigorous method for assessing the amount of uncertainty and offering useful, probabilistic interpretations of isotopic data. As a case study of their utility, my colleagues and I re-analyze geochemical data from construction timbers in Chaco Canyon, an ancestral Puebloan population center. Previous studies used strontium isotope ratios to conclude that the timbers were likely imported from a great distance, which carried major sociological implications for Ancestral Puebloan peoples. Based on previous literature, we isotopically defined the most probable timber origin points as sources in the model, and timbers from Chaco Canyon Great Houses as the mixtures of interest. The Bayesian mixing models revealed high ambiguity in the data and provided no geochemical support for a conclusion favoring distant timber sources over local ones. Current in-progress studies are applying Bayesian mixing models towards isotopically assessing range sizes in primates, and determining contributions of various bedrock zones to the strontium isotopic composition of river water in a Ugandan primate sanctuary. The results of the Chaco case study and ongoing work with these models highlight their utility across anthropological sub-disciplines for all member-of-a-class or source contribution research questions. They provide a means for quantifying the robusticity of results and offering probabilistic, rather than deterministic, interpretations of isotopic data.

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#### **Developmental plasticity in the tibia, but not femur, discriminates between European and US born males of European descent**

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Skeletal elements are differentially affected by environmental insults during development and conform to ecological principles governing body proportions. In particular, the tibia displays a higher degree of sensitivity to environmental insult than the femur. Here, we examine this relationship in a group of late 19<sup>th</sup>/early 20<sup>th</sup> century U.S. males. Individuals sampled completed their growth in either Western Europe or North America and thus they represent two populations that are often combined in bioarchaeological and forensic research. We test the hypothesis that tibia length, but not femur length, will be longer in males born in the U.S. than in those born in Western Europe.

Adult male skeletons were sampled from the Iowa-Stanford collection (n=84). Maximum length of the tibia and femur were measured using an osteometric board (mm). Subjects of European descent were pooled by region of birth (either North America or Western Europe) and tibia and femur lengths were compared between these groups via Mann-Whitney U test ( $\alpha \leq 0.05$ ). Maximum tibia length was significantly longer in males born in the US when compared to males born in Europe ( $p = 0.043$ ). There were no significant differences in maximum femur length between the two groups. These results support that the tibia is a more sensitive indicator of the developmental environment. Moreover, consideration of the developmental environment is warranted when studying adult skeletons in individuals of shared ancestry. These results also support previous observations that immigrants to the US at this time enjoyed a higher quality of life than their compatriots.

#### **A preliminary study of pelvic and femoral shape covariation in anthropoids**

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Current paleoanthropological literature claims that certain pelvic and femoral morphologies should be expected to be found together in hominins (e.g., long femoral neck and widely flaring pelvis in *Australopithecus*). However, the fossil ape *Proconsul nyanzae*, described as possessing a modern-ape femur coupled with a monkey-like pelvis, contradicts expectations. This study aims to quantitatively characterize the patterns of shape variation/covariation between the proximal femur and pelvis in extant anthropoids to test whether specific morphologies should be expected to appear together.

Pelves and femora were scanned and polygonal models were generated. 3D landmarks capturing overall proximal femur and pelvis shapes were collected on the models. Trends of shape variation in each structure were explored



independently with principal components analyses (PCA) on the Procrustes coordinates, and two-block partial least squares analysis (2B-PLS) was used to examine covariation between both skeletal elements.

PCA reveals that major taxonomic groups can be identified relying only on the first axes of pelvic shape variation, especially in apes. To the contrary, femoral shape variation is primarily between monkeys and apes. Although cercopithecids constitute a very homogeneous group for pelvis and femur shape generally, colobines and cercopithecines can be characterized based on femoral shape. Finally, our 2B-PLS reveals a significant but weak relationship between overall pelvic and femoral shapes. These results suggest that specific pelvic and femoral shapes are not necessarily expected to be found associated together in all fossils (being consistent with the fossil evidence). Future studies will focus on specific measures of biomechanical relevance and include fossils.

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#### **Wild female chimpanzees compete for meat**

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Female primates invest heavily in gestation, lactation, and infant care. Because of this, female primate reproduction is typically limited by the ability to turn environmental energy, in the form of food, into offspring. Females are thus predicted to compete for food. While prior field research reveals this to be the case across the Primate Order, few observations of direct contest competition over food have been documented in studies of female East African chimpanzees (*Pan troglodytes schweinfurthii*). Here I present new observations of feeding competition between wild female chimpanzees ( $n = 69$ ) in an unusually large community at Ngogo, Kibale National Park, Uganda. During a 15-month study, I found that female chimpanzees were aggressive to each other occasionally while feeding on plants, but such interactions occurred no more frequently than expected by chance. In contrast, intrasexual female aggression over meat took place relatively often. These bouts comprised 16% of female aggressive interactions, a higher proportion than reported in other East African chimpanzee communities. Although the overall rate of intrasexual female aggression was low (0.01 interactions/hour), rates of aggression over meat were as high as 10 interactions/hour. Results of this study show that female chimpanzee feeding competition varies by context. Female chimpanzees compete intensely over a rare but high-quality food resource, meat, and inter-community variation exists in this type of competition.

#### **The Bioarchaeology of Midwestern Archaic Rockshelters 30 Years Later - Revisiting Modoc Rockshelter, Randolph County, Illinois**

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The Archaic Period in the Midwest is a period of fluctuating population movements, development of trade networks, and innovations in technology and ritual. Holm W. Neumann's 1967 report on the 28 burials excavated from the Modoc Rockshelter represented the earliest detailed skeletal report of an Archaic population in Illinois. For 35 years, Neumann's report continued to influence evolving theories of Archaic population movement, health, and mortuary practices and remained unique among Archaic mortuary sites for the unusual absence of subadults in the burial assemblage.

In the middle 1980s, Modoc Rockshelter site materials were reanalyzed at the Illinois State Museum and additional human remains belonging to at least 12 individuals were identified within the general faunal material bags, including 9 infants or young children, 1 adolescent, and 2 adults.

The reevaluation of the demography and health conditions of the Modoc burials allows us to correlate the new skeletal information with a refined stratigraphic sequence and recent radiocarbon dates to investigate the relationship between mortuary practices, population, and health throughout the Archaic occupation. Results suggest that for most of the Archaic period, all ages and both sexes were interred within the rockshelter. However, during the intensive occupation of Late Archaic Helton phase, only 3 adult female burials were recovered. The absence of additional males and subadults at this time may reflect a shift in mortuary patterns or, alternatively, may be a function of small sample size. This poster summarizes the importance of reanalyzing curated collections to answer current research questions.

#### **Genomic analysis of pre-Columbian tuberculosis from the New World**

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The New World prior and subsequent to the Age of Exploration provides a unique context to explore the relationship between humans and infectious disease. Today human-adapted *Mycobacterium tuberculosis* complex (MTBC) strains are most diverse in Africa, while strains circulating in the Americas most closely resemble those in Europe. Modern genomic analyses of MTBC suggest a worldwide distribution following human dispersals out of Africa during the Pleistocene, leading to hypotheses that pre-Columbian tuberculosis in the New World, for which there is well-accepted skeletal evidence, was either replaced or was caused by a different pathogen altogether.

Previous molecular investigations using ancient pre-Columbian material have identified short conserved regions of mobile elements considered diagnostic for tuberculosis but these offer no information about phylogenetic placement, and are thus difficult to authenticate. Genomic-scale analyses of ancient pathogens capable of addressing this debate have become possible following the application of enrichment techniques and high-throughput sequencing to archaeological and historic samples. Here we report three approximately 1000-year-old ancient mycobacterial genomes from human remains found in Peru, confirming a member of the MTBC caused human infection in pre-Columbian South America. The ancient strains are distinct from any known human-adapted MTBC form and are most closely related to strains adapted to marine mammals, supporting a replacement of pre-Columbian strains after European contact. Two independent dating analyses suggest an emergence of the most recent common ancestor of the MTBC less than 6,000 years ago, implying a Holocene dispersal of the pathogen where marine mammals may have played a central role.

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#### **First virtual endocasts of North American adapiform primates**

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While adapiforms are among the first euprimates to appear in the fossil record and are thus critical for evaluating primate origins, only a small sample of partial natural and latex endocasts



have previously provided the basis for understanding the neuroanatomy of the group. To increase sample size, improve surface resolution, and allow consistent comparisons between specimens, virtual endocasts were extracted using high-resolution X-ray computed tomography from six nearly complete skulls of notharctine adapiforms *Smilodectes gracilis* (n=3) and *Notharctus tenebrosus* (n=3) from the middle Eocene Bridger Formation of Wyoming. The neuroanatomy of notharctines is similar to the Eocene European adapine *Adapis parisiensis* in having small frontal lobes and a cerebrum that does not overlap the olfactory bulbs or cerebellum. The temporal and occipital lobes of *S. gracilis* are expanded relative to *A. parisiensis*, but this condition is variable in *N. tenebrosus*. One specimen of *S. gracilis* preserves the first record of a Sylvian sulcus, a feature otherwise ubiquitous on the brain of all known euprimates, the absence of which in previous specimens of this species was perplexing. Surprisingly, encephalization quotients (EQ) calculated from total endocranial volumes and body masses estimated from M<sup>1</sup> area suggest that *S. gracilis* (0.44-0.53) was relatively more encephalized than its close relative, *N. tenebrosus* (0.26-0.29). However, body mass estimates using postcranial variables suggest that some specimens of both species were of similar size and EQ. Further consideration of body mass estimation methods is warranted before comparisons of relative encephalization should be made between these taxa.

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#### **Mitochondrial aDNA characterization of Cahokia Mound 72**

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Near current day St. Louis, Cahokia was the most complex polity in the late pre-Columbian Eastern Woodlands. Housing more than 10,000 people at its peak occupation, it is clear that Cahokia was of considerable importance; however, the type of power exerted over neighboring territories and more broad regional effects are contested. Determining the type of influence wielded is of particular interest as competing hypotheses range from the entire replacement of outlying settlements from the population center of Cahokia to very limited interactions between Cahokia and the rest of the region. Here we report ancient DNA results from Cahokia's Mound 72 that give insight into the biological relationship between Cahokia and hinterland sites as well as the relationship between high and low status burials within the mound.

Mound 72 is a small ridge top mound located in the southern-central outer edge of the mound structures at Cahokia. The mound contained elaborate burial assemblages with more than 260 individuals that date to approximately 1000 AD, which coincides with the advent of the Mississippian culture. Ancient DNA analysis was performed using non-destructive extraction procedures on 34 individuals from five burial features, including high and low status individuals. The HVS1 sequence for ten individuals (29.4% of the sample) was obtained. Our analysis shows no evidence of significant differences in haplogroup or haplotype frequencies between Cahokia and other contemporaneous sites that have been characterized in the region and highlights the difficulty in working with highly degraded samples and modeling population interactions using PCR-based mitochondrial analysis.

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#### **Paleoanthropology in the Balkans: State of the art and challenges for future**

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The European paleoanthropological record continues to produce unexpected discoveries after more than a century of study, reshaping our knowledge of human evolution on the continent. Over the last 20 years our understanding of the earliest colonization of Europe, of the evolution and paleobiology of Neanderthals, and of the advent of modern humans into the continent, have been radically enhanced due to new discoveries and new approaches to the study of the fossil and archaeological record. Within this research landscape, however, crucial primary evidence is missing from the Balkans in general and Greece in particular. This geographic region is of great interest, as it is both a major dispersal corridor to and from Europe and a Mediterranean refugium for fauna, flora and likely also for human populations. Nowhere is this data gap more evident than in the human fossil record, often consisting of chance finds that lack an excavated context and secure chronology. In our long term collaborative research in Greece, we have contributed to the knowledge of the Neanderthal lineage in the country. We present promising regions for locating new sites on the basis of their sedimentary history, known paleontological localities and paleoenvironmental conditions: the Mani peninsula in Southern Greece, the Mygdonia basin in Northern Greece and the Megalopolis basin in the Peloponnese. The lacustrine sequences of Megalopolis and Mygdonia are well-suited for investigating the earliest human presence in Greece. Alternatively, Mani is dotted

with caves and rockshelters, suitable targets for exploring human adaptations in the Middle / Upper Palaeolithic.

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#### **Earliest direct evidence of modern human-like foot function from 1.5 Ma hominin footprints at Ileret, Kenya**

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The modern human foot generates propulsion during bipedal locomotion using a functional pattern that is unlike any other extant apes. Understanding when this functional pattern emerged during human evolution is complicated by the fact that soft tissues do not fossilize and complete, associated foot and leg skeletons are not known for any early hominins. However, fossil hominin footprints preserve direct records of the external motions of fossil hominin feet, and recent discoveries allow for a new approach to address this question.

Newly discovered 1.5 Ma fossil hominin footprints from Ileret, Kenya were compared to the footprints of habitually barefoot modern humans and the 3.7 Ma footprints from Laetoli, Tanzania. Resampling analyses were used for quantitative comparisons, and 3-D geometric morphometrics were used to visualize morphological differences. Differences were interpreted in the context of experimental results that link patterns of footprint variation to gait biomechanics. The Ileret footprints preserve forefoot morphologies similar to those of modern human footprints, while the Laetoli footprints differ significantly. The 1.5 Ma Ileret footprints therefore preserve the earliest direct evidence of human-like foot function, including a medial transfer of pressure and propulsion derived from the medial forefoot. We argue that this implies a human-like morphology of many, if not all, of the anatomical structures in the legs and feet of the hominins who created these footprints. These results support the hypothesis that an essentially modern human bipedal gait was not present at 3.7 Ma, but evolved in certain hominin taxa by the early Pleistocene.

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**Politics as usual in west-central Illinois? Warfare and violence during the Mississippian Period at Cahokia and beyond**

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This research explores how changes in warfare and violence in west-central Illinois were associated with changes in political centralization in the American Bottom (AB) and Central Illinois Valley (CIV) regions during the Mississippian Period (ca. AD 1050-1400). Frequencies and patterns of healed and lethal skeletal injuries from these regions and the Lower Illinois Valley (LIV) between them were examined. Mississippian political economy models emphasize the use of warfare and structural violence as elite strategies for consolidation of power and authority. It has been hypothesized that centralized elite power at Cahokia in the AB resulted in the suppression of warfare in the region; *Pax Cahokiana*. Our results indicate that political events at Cahokia and in the CIV differentially impacted each region and the LIV in between. During Cahokia's demographic ascendancy from AD 1050-1200, violent rituals were played out in mortuary monuments in the AB and CIV, but skeletal trauma from interpersonal violence was rare. Similarly at Schild in the LIV, the frequency of killings decreased after the adoption of a Mississippian lifeway, but more females and children were killed in comparison to males. After AD 1200, the cultural and demographic "decline" of Cahokia is reflected in dramatic increases in interpersonal violence within the CIV. However, evidence of violence at and around Cahokia is less clear. How levels of violence, the impact of disease, and adverse environmental changes affected regional mound centers is becoming illuminated as more sites are investigated.

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**The impact of past climate cycles on the paleodemography of East African ungulates as inferred from genomic RAD-Seq data**

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Climate cycling and subsequent habitat shifts in East Africa have long been identified as potential drivers of evolutionary change. The impact of

climatic variation on the fauna of the Plio-Pleistocene has largely been inferred through paleontological data, but new genetic tools to probe past population sizes have become available. As East Africa is a location integral to human evolution, understanding evolutionary histories of the taxa of East Africa will ultimately lead to a more comprehensive picture of how and why humans evolved as they did. To address questions of the relationship between climate and ecosystems, we used the latest genomic techniques to investigate population variance in three species of ungulates. By including species of ungulates that occupy different environmental niches, we sought to discover how these populations responded to climate events. Correlating inferred changes in population size with known climate events can ultimately give us a richer understanding of the delicate relationship between climate and ecosystems.

We extracted DNA from 26 museum specimens (skin and tissue associated with skeletal elements) of *Oryx gazella*, *Equus quagga*, and *Equus grevyi* from the Field Museum of Natural History and Yale's Peabody Museum. Using restriction site associated DNA sequencing (RAD-Seq) with the enzyme PspXI on an Illumina HiSeq 2500 platform, we generated >1,000 single nucleotide polymorphisms from >40,000 loci. Effective population size variance over time was inferred using approximate Bayesian computation. Initial demographic analyses suggest shifts in effective population size associated with changes in paleoclimate.

**Education and outreach components of the Rising Star Expedition and Rising Star Workshop**

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Paleoanthropology field projects and laboratory research are engaging to both the public and K-12 audiences. Still, education/outreach directly from field projects has often been seen to impede or distract from research effort. The Rising Star Expedition integrated a massive outreach component from the instigation of field operations, with multiple channels of direct public and K-12 contacts. The later Rising Star Workshop also integrated education/outreach directly in the process, under a somewhat different model of interaction. Here I discuss both quantitative and qualitative measures of outreach effort and impact. From blogs and Twitter to short video lessons and classroom interactions, these components enhanced the research project in several creative ways. These projects may provide a new model of "broader impacts" for paleoanthropology.

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**Current developments in anthropological genetics of the North American Arctic**

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The North American Arctic is one of the last regions of the globe to be continuously occupied by humans, and understanding the population (pre-)history of the region has been of considerable interest to anthropological geneticists. Crawford and colleagues used classical genetic markers to identify close ancestry between North American arctic inhabitants and Native Siberians, concordant with earlier craniometric analyses. Over the past two decades, our research programs have furthered this by investigating the genetic relationships among North American arctic inhabitants through space and time to further elucidate the peopling of the arctic. We used mitochondrial DNA polymorphisms to investigate questions of population continuity vs. replacement in the Aleutian Islands (Paleo- vs. Neo-Aleuts) and Eastern Canadian Arctic (Paleo- vs. Neo-Eskimos). In both cases, our results supported a modified view of the archaeological record of continuity in the former and replacement in the latter, in contrast to previous craniometric interpretations. Our more recent, ongoing investigations have increased the density of mitochondrial markers to entire mitogenomes, as well as nuclear genomic variation. Most recently, we have focused our efforts on the Inupiat population of the North Alaskan Slope. We find evidence for all mitochondrial haplogroups present among Paleo- and Neo-Eskimo populations further east among the contemporary inhabitants of North Alaska, and most such lineages are also observed in the ancient population of Nuvuk. This suggests this region/population is the launching point for the eastward migrations of both Paleo- and Neo-Eskimo populations, and that some continuity among these groups occurred in this ancestral region.

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### Evaluating ontogenetic shape variation in the mandibular ramus of *Homo sapiens* and *Homo neanderthalensis*

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Mandibular ramus form varies among extant great apes and humans, as well as Middle and Late Pleistocene *Homo*. In extant hominoids, species-specific ramus form appears early during ontogeny; however, it remains unclear when the reported shape differences appear between *Homo sapiens* and *Homo neanderthalensis* during growth and development. The present study expands upon previous work by further evaluating shape differences between adult *H. sapiens* and *H. neanderthalensis* and incorporating subadult *Homo* specimens.

Two-dimensional sliding semilandmarks were used to quantify ramus shape in extant and fossil *H. sapiens* and *H. neanderthalensis* ( $n=286$ ). Principal component analysis was used to summarize shape variation, and Procrustes distances were employed to quantify differences between groups. Ontogenetic allometric trajectories in shape space were examined using multivariate regression.

Results show that, while *H. neanderthalensis* and *H. sapiens* ramus shape is significantly different, these differences are subtle. The average *H. sapiens* ramus displays a narrow coronoid process that is of roughly equal height as the mandibular condyle, while *H. neanderthalensis* possess an anteroposteriorly wider coronoid process that is taller than the mandibular condyle. Although the ontogenetic trajectories for *H. neanderthalensis* and *H. sapiens* are not significantly different, mandibular form differs significantly between species in most age categories, beginning with the youngest individuals. However, there is considerable variation within each species at each age category. These results suggest that while the mandibular ramus can be used to differentiate hominoid taxa, caution should be exercised when using it as a diagnostic trait for *H. sapiens* and *H. neanderthalensis*.

### A second look at the tibial arch angle and its use to reconstruct longitudinal arch height in fossil hominins

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In humans, the posterior margin of the distal tibia articular surface has a greater inferior projection than the anterior margin, creating an anteriorly-

inclined ankle joint in the sagittal plane ("tibial arch angle", TAA). Previous work found a significant relationship between the TAA and radiographic measures of arch height, and proposed that an anteriorly-inclined ankle joint is a developmental by-product of longitudinal arch development in humans (DeSilva & Throckmorton 2010). Currently, however, our understanding of the TAA and how it relates to the arch is limited.

This study further tests the relationship between the TAA and the longitudinal arch. First, a sample of adult foot and ankle x-rays ( $N=120$ ) was used to investigate the relationship between the TAA and arch height. Second, ontogenetic changes in TAA morphology were catalogued in juvenile skeletal remains from two archaeological populations to test whether the anterior inclination of this joint develops concurrently with the arch. OLS-regression of TAA on a clinical measure of arch height reveals that variation in the TAA explains less than 1% of the variance in arch height for the adult radiographic sample ( $r^2=0.0089$ ,  $p=0.344$ ). For the ontogenetic sample, individuals in the age range spanning arch development (0-6 years) had lower, but not significantly different, TAA values than older individuals, suggesting that the anterior inclination of the joint is not a by-product of arch development. These results question the link between the TAA and longitudinal arch height, and also whether this trait should be used to reconstruct arch height in fossil hominins.

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### The ISAS Cahokia Project: Rediscovering Ancient Cahokia

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Cahokia Mounds State Historic Site marks the location of the largest prehistoric mound center in North America and is considered the center of Mississippian culture from ca. A.D. 1050-1350. Archaeological investigations at Cahokia have influenced our interpretations of the social, political and cosmological organization of Mississippian Culture in North America, while burials from Cahokia Mound 72 have featured prominently in early studies of diet, health, demography, and biological relationships. This poster summarizes the history of archaeological investigations and interpretations of Cahokia and highlights results from the ISAS Cahokia Project.

The Illinois State Archaeological Survey (ISAS) Cahokia Project is a long-term, multi-disciplinary research project that seeks to

identify factors that contributed to the rise and fall of the Cahokian polity. Ongoing analyses of both recently excavated and curated human remains from Greater Cahokia, including those associated with Mound 72, offer new information on the health, diet, geographic origins, and genetic relationships of individuals living in, and interacting with, Cahokia.

Of particular interest are new details from Mound 72 that impact long held interpretations of social organization and interactions. These include the identification of two male/female paired burials associated with the central beaded cape feature (F101); a previously unknown example of modified teeth within a mass burial (F105); and a more complete isotopic dataset that identifies heterogeneity in diet and place of origin within Cahokia. This project highlights the research potential of older collections, the value in reconsidering long held assumptions, and celebrates the collaborative relationships forged through multi-institutional and multi-disciplinary research.

### Biological distance analysis: An analytical history of methods

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Biological distance, or biodistance, is an analytical method for measuring relative relatedness (or divergence) within and between groups using morphological and metric variation. The observational studies of the early 20th century laid the foundation for the analysis of population relationships in anthropological contexts and hinted at the potential for these traits to distinguish populations. The descriptive studies of morphological skeletal traits in site reports were (and, in many ways continue to be) quite common, which makes pinpointing the exact origins of biological distance studies difficult. However, during the 1950s and 1960s studies utilizing biological distance measures begin to appear in anthropological journals.

Over the last sixty years, biodistance methods have been refined, due in large part to the work of geneticists interested in skeletal morphology and past populations, and also due to advances in statistical techniques. This study aims to explore the history of biodistance analysis through an application of multiple methods to the same dataset ( $n = 230$ ) representing various populations across the globe. Data for each individual include: cranial and dental nonmetric traits and craniometric variables. Analyses consist of several methods from published biodistance studies over the past several decades, including: Penrose's size and shape statistic, mean measure of divergence, Mahalanobis'  $D^2$ , cluster analysis, principal components, Euclidean distance, and the R-matrix. The differing results



of each method highlight advances in the field, as well as the need to choose appropriate analytical methods.

#### **Betwixt and Between: Central Asians and the Eurodont-Sinodont Dental Complexes**

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The Eurodont dentition of Western Eurasia is characterized by crown simplification and a high incidence of relatively few traits, including Carabelli's cusp, LP2 multiple lingual cusps, three-cusped UM2, four-cusped LM1 and LM2, and two-rooted LC. The Sinodont dentition of Northeast Asia is characterized by crown intensification and root simplification, including high frequencies of U11 winging, U11 shoveling, U11 double shoveling, premolar odontomes, UM1 enamel extensions, LM1 cusp 6, LM1 protostylid, one-rooted UP1, and three-rooted LM1. In the heart of Eurasia, there is a geographical gray area between the two dental complexes, where populations are often referred to as Central Asians. Our question is whether or not these populations show more affinity to the west (Eurodont) or east (Sinodont), or if they fall somewhere between these extremes. Twelve morphological dental traits from 20 samples (total n= 2370) representing Europe, Northeast Asia, and Central Asia were analyzed. An unrooted tree based on a Bray Curtis dissimilarity matrix shows distinct branches on each end representing the Eurodont and Sinodont patterns. Five samples fall between the two extreme branches, with four of the five representing Central Asian groups. Although there is Central Asian intermediacy between the Eurodont and Sinodont complexes, two groups that are considered Central Asian (Uzbekistan, Tajikistan) fall within the Eurodont branch of the unrooted tree.

The authors are indebted to the late Christy G. Turner II for the use of his data set.

#### **Cranial clusters: Mortuary patterns in Eneolithic Verteba Cave, Western Ukraine**

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Relatively little is known about the Eneolithic Tripolye-Cucuteni mortuary practices, as there are few known cemeteries. Here, we describe excavations of human burials from Verteba Cave located in Western Ukraine during the summers

of 2008 and 2012. Ceramics and carbon dating place the cave use between approximately 3951 to 2620 cal BC. Commingled human cranial and post-cranial remains were excavated along with comingled faunal elements, bone and lithic tools, ceramic figurines, pottery, and spindle whorls. Two cranial clusters were found each containing four skulls positioned in a circle. The first cluster contained one young adult female, two adult males, and one unsexed adult. The female and two males exhibited injuries resultant from blunt force trauma. The second cluster contained three adult males, and one adult female, and was accompanied by an aurochs horn. All of these crania had peri-mortem cranial fractures. Eight other crania were found along with cave wall and two partial calvaria were found in a nearby area of the cave. Four of these crania also exhibited peri-mortem trauma. The lack of mandibles associated with the crania indicates that they were likely de-fleshed before their placement in the clusters. The placement of only some of the crania into clusters suggests differential treatment for individuals, which may be indicative of differing social status or societal roles. These head burials are consistent with some Mesolithic cranial clusters from Germany where individuals were also victims of violence.

#### **Probability of finding a Pleistocene Down Syndrome skeleton on Flores**

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A recent diagnosis of the LB1 skeleton as that of an individual with Down Syndrome (DS) has been questioned. It is doubted whether a DS person could be born and survive to the age ~30 yrs in an island hunting-gathering population. We assess this doubt quantitatively, assuming low probabilities of DS birth and survival. On Flores (14,300 km<sup>2</sup>) in the Pleistocene population would be about 1430 persons assuming density of 1/10 km<sup>2</sup>. With the non-Malthusian population crude birth rate ~5% per year, 72 neonates would be born on Flores annually. With 1 DS birth per 2000, 1 DS child would be born every 28 years. The volcanic tuff covering LB1 accumulated about 12 ka ago. Assuming that *Homo sapiens* arrived on Flores 40 ka ago gives 28,000 years during which 1000 children with DS could be born. Survivorship to age 30 years of normal (non DS) people in a prehistoric population is about 0.22. Today, survivorship of DS patients to age 30 is ~50% of that of normal individuals. Assuming that in the past DS survivorship was much poorer, five times worse, a number of 22 DS patients surviving on Flores to age 30 years before the beginning of the Holocene is obtained. It is possible that a skeleton of one of them might have been preserved in a karstic cave like Liang

Bua, considering favorable taphonomic circumstances evidenced by preserved faunal remains. Adult DS skeletons are known from archaeological sites such as Tauberbisfordsheim (Czarnetzki et al. 2003).

#### **A revised method for estimating age-at-death from palatal sutures using Bayesian statistics**

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Age estimation from human skeletal remains is a critical biological parameter in both forensic and bioarchaeological contexts. Recent significant developments in age estimation indicate that a sound theoretical approach to aging requires the application of Bayes' Theorem and transition analysis. Palatal sutures have seen very little testing and/or application since their original introduction by Mann and coworkers (1991), despite the fact that they are routinely collected as a part of skeletal inventory and analysis.

In this study, a revised method of scoring was developed to examine fusion in five regions along the four main palatal sutures. These scores were summed and divided into 7 statistically meaningful phases. This revised method was applied to a documented sample of modern adult males from the Bocage Collection, (n=202) (Lisbon, Portugal) to derive transition analysis parameters. Using the Bayesian approach, these ages-of-transition were combined with hazard parameters obtained from an informative prior of Thai males and used to estimate age in a documented sample from the WM Bass Donated Collection (n=361). Final age estimates were tested for significance and accuracy using cumulative binomial tests, based on the highest posterior density regions ("coverages") at 50%, 75%, 90% and 95%. The coverages demonstrated a higher probability of success at each level.

The revised method presented here, coupled with a Bayesian approach, is advantageous for estimating age, especially for older individuals. We strongly support the use of transition analysis with Bayesian statistics to estimate age in archaeological and forensic contexts.

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### Stories in Bones Still Told: Digitization of The Clover Site, Fort Ancient human remains

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The topic of human skeletal analysis is a sensitive subject in North America. Laws and regulations surrounding excavation and research of human skeletal material make it difficult to use these remains to characterize Native populations. Recent technology has the potential to solve this dilemma. Three-dimensional (3D) scanning can create virtual models of this material, and store the information so it will not be lost when the original material is repatriated. To assess the potential of this methodology, I compared processing time, accuracy and costs of computer tomography (CT) scans to the Artec Eva portable 3D surface scanner. Using both methodologies I scanned one adult individual uncovered during an archaeological excavation of Clover, a Fort Ancient civilization in Cabell County, West Virginia. I hypothesize that the Artec Eva will create digital replicas with < 3% error based on Buikstra & Ubelaker standard osteometric measurements. This was tested by comparison in measurements from the material and CT data. Results show that larger bones recorded by the Artec Eva have < 3% error of the original specimen while smaller more detailed images have > 3% error. While the CT images show < 3% accuracy. The Artec Eva scanner is inexpensive in comparison to a CT machine, but takes twice as long to process the Eva's data. The Artec Eva will be sufficient in replication of larger elements, but the CT machine is still a preferable means of skeletal replication, particularly for small elements.

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### Integrating Anthropology and Biology: Comparing success rates and learning outcomes across majors when taking Human Evolution

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A charge to bioanthropological curriculum development is generating learning outcomes for substantially different backgrounds of anthropology and biology majors. A primary concern is how prepared anthropology majors are for biology content; anthropology curriculum does not always require biology prerequisites. As bioanthropological research relies increasingly

on genetics/phylogenomics, strong emphasis needs to be put on integrating biological content.

The core-level "Human Evolution" course at Virginia Commonwealth University is taught under an anthropology rubric. It is required for anthropology majors, and serves as a lab-based elective for biology majors. The course is divided into four primary units: two covering topics that are also explored in lower-level biology courses (e.g., DNA inheritance), and two focusing on paleoanthropological content (e.g., hominin taxonomy). Here, we compare results of course assessments and final course grades between anthropology and biology majors across five semesters and >200 students to determine whether the two majors performed differently on units with "biology" content vs. "anthropology" content.

Preliminary results of a series of statistical tests reveal that overall, anthropology and biology majors are earning comparable final grades in the course. However, when assessment results for units with differing content are contrasted, anthropology and biology majors scored comparably on "biology" content units, while biology majors scored statistically significantly worse on "anthropology" content units. These results might suggest that biology rather than anthropology majors are deficient in an integrated bioanthropological perspective. We recommend that anthropology and biology departments consider introducing integrated curriculum that is interdisciplinary rather than multidisciplinary by design.

### Quantitative Analysis of Drift versus Selection in Prehistoric South American Populations

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Evolutionary influences on cranial shape among prehistoric South Americans continue to spark debate, due to the high observed diachronic morphological diversity seen in the continent. The discussion about the origins of this diversity in the past has suggested different evolutionary forces driving the process, including responses to environmental forces (natural selection or environmental plasticity), as well as stochastic processes (isolation by distance, restricted gene-flow, etc). Based on these assumptions, many different models have been proposed to explain the human dispersion in the continent. However, the role of different evolutionary forces in shaping the human cranial morphology in the continent has not been evaluated. Here, we test the relative importance that natural selection had on the differentiation between the early Paleoamerican and recent Native South American groups based on Lande's quantitative evolutionary theory. We compared early Holocene Paleoamerican Colombian and Brazilian populations with late Holocene South

American groups (Tupi, Botocudo, Brazilian shellmounds, and Peruvian). Our results show that between group diversity is proportional to within group diversity when compared to Peru, lower than expected when compared to Botocudos and Shellmounds, and higher than expected when compared to Tupi. These results suggest that, while genetic drift may have been enough to explain the morphological differences in a few cases, the evolutionary history of cranial shape likely derives from a combination of random and non-random factors, and varied in different regions of the continent, highlighting that the origin of diachronic morphological changes in the continent cannot be seen as a linear process.

### Environmental instability and functional traits explain lemur ecological community structure

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Community ecology predicts how species assemblages are shaped by abiotic and biotic factors. The phylogenetic structure of communities (PSC) integrates evolutionary and ecological data to tease apart subtle differences in the mechanisms of community assembly. Communities consisting of species which are more closely related than expected by chance and share similar functional traits (clustered) are predicted in environments that filter species assembly. Over-dispersed communities are predicted when competition and niche partitioning limit the co-existence of closely related species. Disturbance randomizes species assembly as local extinctions create opportunities for colonizing species. I surveyed lemur abundance along environmental gradients of elevation and anthropogenic disturbance using distance sampling techniques in southeast Madagascar between 2011 and 2014. I tested if functional traits (group size, diet, life history) are related to environmental adaptation and niche partitioning to elucidate patterns in PSC. Community structure in disturbed habitats did not differ from random expectation (mean Nearest Taxon Index, NTI = -0.6 permutation tests of PSC,  $p > 0.05$ ), likely because environmental stochasticity created frequent opportunities for invasion by colonizing species. In contrast, the PSC in pristine forests was significantly clustered (mean NTI = -1.5,  $p < 0.05$ ) because closely related species with similar functional traits (large group size and frugivory) had high relative abundance. Elevation and disturbance explained ~50% of variation in PSC (ANCOVA,  $F=4.147$ ,  $p < 0.05$ ). In sum, lemur PSC is shaped by environmental instability and the ability of some species to dominate communities.

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**Understanding the quality of health care available at the Erie County Hospital, Buffalo, New York, 1880-1910**

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The Erie County Poorhouse (1829-1926) served the city of Buffalo as an almshouse, insane asylum and hospital. The hospital provided regular medical care, surgical care, obstetric and gynecological care for inmates of the poorhouse and Buffalo residents who could not afford alternative health care. This study seeks to understand the medical care available, through the hospital, to the city's poor.

Included in the annual report of Keeper of the Erie County Almshouse was a summary of the patients treated. Patient statistics were calculated using these data for the period of 1880-1910. Of the 42,351 people served by the hospital during the period, the percentage of people discharged as cured decreased through time from a high of 60% in 1894 to 26% in 1908.

The mean number of patients per year increased from 113 in 1880 to 420 in 1904, with the hospital beginning to reach its 400 bed capacity in 1903. However, inventories of the laboratories, kitchens, etc. suggest that the hospital had sufficient supplies and equipment to treat the patients there. Furthermore, the crude death rate increased through time from a low of 99 per 1000 population in 1882 to 216 deaths per 1000 population in 1907. The increased frequency of tuberculosis in Buffalo during this period may account for the increasing CDR through time.

While the data suggest that the ECPH Hospital provided adequate care through most of the period examined, a more detailed analysis of the diseases treated and age distributions will be reported.

**Degenerative Joint Disease in the Hands and Feet Relative to Sex and Body Mass: A Study of Skeletons from St. Nicholas Cemetery in Limassol, Cyprus**

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The purpose of this research is to provide a paleopathology assessment for the exhumed remains from the St. Nicholas Cemetery of Limassol, Cyprus. These remains are unique in that they have demographic information specific to age and sex and that they are mostly geriatricians. In this project we focus specifically on the degenerate joint disease (DJD) of joints

from the hands and feet of 33 individuals. In doing so, degenerate joint disease is assessed by joint in regards to the presence and severity of lesions exhibiting microporosity, macroporosity, lipping, osteophytes, eburnation, and joint fusion. Although, (DJD) can be found on articular joints throughout the body; with the shoulder, knee, hip, and vertebral joints, most commonly affected areas; DJD specific to the hands and feet are not well discussed in the literature. In evaluating the frequencies of these lesions we use factors such as sex, age grouping, body mass and stature. Skeletons in this sample range from 30-100 years of age, 51.5% are males and 48.5% are females. Results show that women, in this population, exhibit higher frequencies and severity of DJD in both the hands and feet compared to men; suggesting that body mass is not a factor in the frequency of lesions specific to the hands and feet.

**Experimental Assessment: Heavy Bladed Tool Mark Analysis in Relation to Dismemberment and Its Implications for Forensic Identification**

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Although there a number of reports specific to dismemberment, it appears that more research is required. The purpose of this project is to contribute to the literature and techniques associated with the identification of tool marks caused by heavy bladed instruments during dismemberment. This research attempts to match specific trauma patterns with a specific weapon (machete or axe). In addition, the fracture patterns are studied in an attempt to reconstruct the number of blows that occurred during the dismemberment process. A number of variables are accounted for such as soft tissue depth, the time it takes to dismember limbs, and the body weight of the volunteers used to dismember the limbs. A macroscopic assessment of the trauma produced during this experiment is used to identify the tool used and the number of strikes. Fully fleshed pig limbs (*Sus scrofa*) were dismembered by 4 volunteers in a blind test in which the main researcher MH was not present. The weight and height of the tools and volunteers were taken in order to demonstrate the range of variability possible when heavy bladed tools are wielded. The difficulty of assessing tool type shows that it may not be possible to differentiate between machete and axe strikes.

**Risk minimization and a late Holocene increase in mobility at Roonka Flat, South Australia: an analysis of lower limb diaphyseal shape**

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The Roonka Flat skeletal sample from South Australia includes the remains of Aboriginals buried throughout the Holocene (8,000 – 200 BP), and thus provides the ability to test how humans were affected by climate change in the prehistory of this continent. The development of the El Niño Southern Oscillation (ENSO) ~4 kya caused significant changes in climate, vegetation, and faunal assemblages between the early Holocene and the late Holocene. Archaeological deposits show the appearance of a lighter, more flexible toolkit corresponding with the transition from wetter and warmer conditions pre-ENSO to cooler and dryer climate post-ENSO. This has been interpreted as being indicative of a risk-minimization strategy that leads to an increase in foraging mobility. This was tested by examining changes in lower limb external diaphyseal shape between pre-ENSO and post-ENSO skeletons from Roonka Flat. Anteroposterior diameter and mediolateral diameter were used to construct midshaft shape indices for femora and tibiae. If populations living in South Australia became more mobile, then post-ENSO skeletons should exhibit more ovular lower limb diaphyses. Results from the femur demonstrate significantly more ovular diaphyses post-ENSO. These data are consistent with the risk-minimization model, indicating that South Australians became more mobile post-ENSO to better exploit a less productive environment by expanding their foraging radii. The temporal shift toward more ovular diaphyses is more notable in females than males. This is consistent with Australian Aboriginal ethnographies that show both sexes being intensely involved in hunting and capturing game animals.

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**Life history trade-offs as a function of mother's milk: Consequences for juvenility and transitions to adulthood**

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For mammals, mother's milk is an important physiological pathway for nutrient transfer and glucocorticoid signaling. We investigated mother's milk and infant temperament and growth in a cohort of rhesus macaque (*Macaca mulatta*) mother-infant dyads at the California National Primate Research Center (N=108). Glucocorticoids in mother's milk, independent of available milk energy, predicted a more Nervous, less Confident temperament in both sons and

daughters. Importantly, higher cortisol concentrations in milk were associated with lower maternal parity and greater infant weight gain across time. Taken together, these results suggest that mothers with fewer somatic resources, even in captivity, may be "programming" through milk signaling, behaviorally cautious offspring that prioritize growth above behavioral exploration. A majority of these individuals (N=84) remained in the breeding colony to assess survival, mass, and, for females (N=48/84), the age of reproductive debut. Mother's milk and early life temperament predicted offspring outcomes. After accounting for relevant co-variables during AIC model selection, nervous temperament was associated with higher mortality in both sexes, but not growth, and delayed reproductive debut for females. Mass in juvenility was associated with milk produced by the mother years earlier, but sons were seemingly sensitive to milk glucocorticoids while daughters were seemingly sensitive to milk energy. Glucocorticoids ingested through milk may importantly contribute to the assimilation of available milk energy, development of temperament, and orchestrate, in part, the allocation of maternal milk energy among life history tradeoffs during early life biobehavioral organization with consequences persisting after the period of maternal dependence.

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#### **Arrangement of the foot interosseous muscles in great apes**

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The dorsal interossei of the human foot are arranged so that they abduct the digits around the second digit, while those of non-hominoid anthropoid primates are mostly arranged around the third or fourth digit. This is thought to be related to the medial shift of the functional axis of the foot in humans, which was an essential modification necessary for the evolution of the human foot (Morton, 1922), and makes the interossei "the most interesting muscles of the foot" (Manter, 1945). However, studies on arrangement of the interosseous muscles are relatively limited, and their results on apes are not necessarily in accord. Some researchers claimed that the interossei of the chimpanzee are arranged around the second digit, whereas others reported that the foot axis lies on the third digit in the same species. In this study, we examined the arrangement of the interosseous muscles of the foot in eight chimpanzees, one bonobo, two

gorillas, and four orangutans. Results showed that in two chimpanzees and a bonobo the dorsal interossei were arranged around the 2nd digit, while in the rest of the specimens the 3rd digit had two insertions of the dorsal interossei, suggesting variation exists in great apes. Considering that the osteological studies support the idea that the foot axis is on the 2nd digit in great apes, it seems that the osteological change concerning the foot axis phylogenetically exceeded the change in the arrangement of the interosseous muscles.

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#### **Accomplishing broader impact through secondary school teacher workshops in Arusha, Tanzania**

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From 2010-2013, a National Science Foundation funded paleontological research project based at Olduvai Gorge, Tanzania, included in its broader impacts and outreach goals a series of Teacher Workshops run by the National Natural History Museum in Arusha. These workshops were the vision of the NNHM's director and staff and were included collaboratively in the grant proposal after extensive discussions on how to synergize the research project with the outreach goals/needs of the hosting museum. The NNHM Director (Mangalu) developed the workshop curriculum as would best suit the local area's needs and relationship with the Museum. In total, 148 science teachers from over 100 secondary schools in the Arusha area participated in one of the nine 2-day workshops. These workshops provided them with the opportunity to brainstorm ways to teach science in their local situations and to make connections with other teachers, raising enthusiasm and motivation. While the workshops provided an opportunity for teachers to network and renew their enthusiasm, they also included content from the Understanding Science project run by the University of California Berkeley's Museum of Paleontology, producing a Kiswahili translation of the concepts flow-chart, furthering the outreach goals of that education project as well. Following this series of workshops, the Tanzanian government has indicated interest in further supporting such efforts and many of the teachers have self-organized into a club that continues their collaborative efforts. Additionally, a significant number of the students of the teacher-participants have become formal "museum friends" and now volunteer on a regular basis.

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#### **Testosterone, strength, and the ontogeny of the male face**

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For many species, the emergence of secondary sexual characteristics co-occurs with the onset of sexual maturation and is facilitated by sex-typical hormones, e.g., an adolescent surge of testosterone for human males. Many male facial features – particularly in the jaw and midface – are considered secondary sexual characteristics. Therefore, we predict the size of these features will be correlated with adolescent testosterone levels. Using a peripubertal sample of hunter forager-horticulturalist males, we measured the size of individual facial features as well as salivary free testosterone. Controlling for interpupillary distance, measures of the jaw and midface are correlated with testosterone levels, and these effects persist when age is controlled. Previous studies of peripubertal males have found similar effects when considering only hard tissue; we complement these data by capturing the emergent properties of both soft and hard tissue. To our knowledge, this is the first study to establish the adolescent developmental link between testosterone and facial features utilizing the combined effects of soft and hard tissue. This suggests that the secondary sexual facial features typical of adult men are established under adolescent testosterone levels and that they are honest signals of testosterone load.

#### **Modern human origins in Southeast Asia: behavioral perspectives**

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It is generally accepted that modern *Homo sapiens* were the first hominin group to have peopled Australia sometime after 60 ka, a dispersal that could only have been facilitated by the presence of a "modern" human behavioral toolkit that included watercraft, deep sea fishing gear, hafted weaponry, and perhaps symbolic behavior. Because Southeast (SE) Asia was the likely corridor through which these modern human groups moved, we hypothesize that comparable behavioral evidence around the same time or possibly even a little earlier should be present in SE Asia. The results of our study indicate that: 1) Tabon Cave (Philippines), with deposits dating to between 58 ka and 37 ka, could only have been occupied by humans



capable of crossing large bodies of water. 2) The earliest evidence of a broad spectrum diet, hafted weaponry, long-distance import of raw materials and deep sea fishing date between 42 ka and 30 ka and are concentrated at Niah Cave (Sarawak, Malaysian Borneo), and Lena Hara Cave and Jerimalei (East Timor). 3) The earliest evidence of symbolic behavior appears between 35 ka and 25 ka in the form of shell beads from Matja Kuru 1 and 2 (East Timor) and Lena Hara and a burial at Moh Khiew (Thailand). By 42 ka, if not a little earlier, at least pieces of the modern human behavioral toolkit that would have facilitated the human dispersal to Australia are present in SE Asia. The broader implications of the Southeast Asian Late Pleistocene human behavioral record are discussed.

**Preliminary results of the bioarchaeological investigation of an Iron Age tomb at Wadi Fidan 61, Jordan**

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Wadi Fidan is the gateway to the Faynan district, one of the largest sources of copper ore exploited by ancient societies in the southern Levant. This report describes the preliminary analysis of a tumulus at Wadi Fidan 61 (WFD61) excavated in 2012. WFD61 is located in close proximity to and contemporaneous with a previously excavated cemetery WFD40. WFD61 contained an undisturbed context with a minimum number of 17 simultaneous primary burials (13 adults, 4 subadults) distinct from a more recent looted context with a minimum number of 3 adults and 3 subadults. The well-preserved remains of the tumulus provide an excellent opportunity to expand our understanding of the overall health and activity patterns of this Iron Age population. Standard protocol data collection was used for age, sex, and pathological assessment. Preliminary results indicate the existence of infectious disease and malnutrition (through periostitis and cribra orbitalia) and a high prevalence of dental pathology including LEH, antemortem tooth loss, severe attrition, abscesses, caries, and periodontal disease. High frequencies of DJD and healed trauma suggest that individuals were habitually involved in hard physical labor and perhaps copper mining. These findings are consistent with previous studies of the WFD40 cemetery. Two hypotheses regarding the relationship between the tumuli and nearby cemetery are discussed: spatial segregation of the sites may be attributed to either a temporary spike in mortality from acute disease or previously undetected mortuary variation by kin group. Future work will incorporate biodistance and biochemical analyses for further testing of these hypotheses.

**Uniting perception and reality in human nutrition: integration of qualitative and quantitative data to understand consumption**

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The process of food consumption involves both the food items that are eaten and the meanings with which they are associated. Human nutrition studies commonly focus on evaluating the intake of particular nutrients in comparison to daily recommended intakes using food frequency questionnaires, food diaries, or dietary recalls. While these methods can ascertain sufficiency or deficiency, they do not provide insight into individual beliefs related to consumption. Individual perceptions of nutrient intake underlie decisions regarding consumption and influence motivation to alter eating habits. Qualitative methods provide the necessary depth to investigate perceptions and meanings related to food. To fully understand the process of consumption, qualitative and quantitative methods must be united. This paper focuses on the integration of datasets in a study of calcium and vitamin D intake in young adults. Food frequency questionnaires were used to calculate actual nutrient intake and interviews were used to explore perceptions related to consumption. Young adults were identified as under-consuming both nutrients; however, when their perceptions of their consumption were investigated, the majority of young adults believed they were consuming an adequate amount of calcium and vitamin D. The beliefs of these young adults were based on their personal interpretations and understanding of the availability and importance of calcium and vitamin D from foods. These results reveal a disconnect that emerged through the consideration of two disparate data sets and advocate for mixed method approaches in nutritional anthropology.

**Improving access to socioeconomic data for genetic studies of racial health disparities**

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Researchers are increasingly using clinic-based biological databanks in genetic studies as they can provide accessibility to a large population with longitudinal phenotypic data. Typically, the only environmental data linked to these samples are those extracted from electronic medical records (EMRs). Anthropological studies have

demonstrated the importance of socioeconomic data in contributing to a variety of diseases. Socioeconomic status (SES) is an important factor to consider when analyzing racial disparities in health, yet is rarely included in genetic studies, due in part to the difficulty in collecting socioeconomic data when samples are not directly ascertained for that purpose. We developed a SES score using information available within the EMR of the Vanderbilt University Medical Center biobank, BioVU. Using ~16,000 individuals, we employed a combination of free-text searches and ICD-9 codes to extract relevant SES data. Results suggest that occupation and education level are two important SES elements that can be extracted from the EMR. We identified ~11,000 individuals with education information and ~15,000 individuals with occupation information. Occupation, education, health insurance, homelessness, and other variables have been incorporated into a summary SES score. This score will be validated in a comparative sample in which EMR data and surveys with SES information are available. This algorithm will enable biobank genetic studies to incorporate SES data into their analyses. Ultimately, measurement of SES will help to elucidate the impact of social environment on racial disparities in common diseases.

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**The New and Old in Hominid Brain Evolution: Why Paleoneurology Needs the Lunate Sulcus**

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The lunate sulcus, sympleisomorphic in pongids, separates area V1 (primary visual cortex) of the occipital cortex from parietal association cortex, and in hominids and modern humans is placed posteriorly compared to pongids, and is an important landmark with anatomical reality in delineating the anterior limit of area V1. It is crucial to arguments regarding whether brain reorganization preceded brain enlargement in early hominid evolution. Most recently, Falk (2014) has suggested that we get rid of the lunate sulcus as it appears unlike a true "Affenspalte" as found in other primates, and is variable in modern humans as shown by Allen et al (2006). Much more of an issue, however, is Falk's suggestion that the clear-cut lunate sulcus on the Stw505 (*A. africanus*) specimen is possibly a lateral calcarine sulcus.



We will show that the lateral calcarine NEVER appears on any of the ca. 300 ape (bonobos, chimps, gorillas, orangs, hylobatids) or human endocasts in our collection, while the lunate sulcus, either as a complete crescent, or a broken sulcus appears on all pongid and most human brains, demonstrating that the crescentic furrow on Stw505 cannot be a lateral calcarine sulcus. Furthermore, since the lunate appears on Stw505, AL 168-28 (*A. afarensis*), and on the Taung specimen as Dart described it in 1925, and is reported on some of the *Homo erectus* and Neandertal specimens, it makes no sense to rid paleoneurology of this crucial landmark which bears on the important issue of when brain organization took place.

#### Primitive fist-walking and the radiocarpal morphology of *Rudapithecus hungaricus*

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This study presents a quantitative analysis of the radiocarpal joint of the late Miocene European hominoid *Rudapithecus hungaricus*. We compare two newly discovered fossil specimens, a scaphoid and a lunate, from *Rudapithecus* to a large sample of extant anthropoid specimens and two Miocene fossil apes, *Proconsul* and *Equatorius*. First, we show that the angle at which the scaphoid and lunate articulate demonstrates a morphological pattern that can be used to distinguish between hominoids and other anthropoids. Cercopithecoids and platyrrhines have larger articulation angles compared with hominoids, a trait that strongly correlates with increased mediolateral wrist stability and pronograde quadrupedalism. *Rudapithecus* has a scaphoid-lunate articulation angle which is more similar to extant hominoids (*Pan*, *Gorilla*, *Pongo*, and *Hylobates*) than the extinct hominoids, cercopithecoids, or platyrrhines. Secondly, we quantify the relative carpal contribution to the radiocarpal joint, a feature that can be used to discriminate between Hylobatidae, Homininae, and Ponginae. In *Pan* and *Gorilla* the scaphoid occupies over 50% of the carpal portion of the radiocarpal joint. In *Pongo* and *Rudapithecus* the opposite is true, and it is the lunate that dominates the wrist joint. This particular feature suggests greater dorsoventral flexibility for *Pongo* and *Rudapithecus*, and greater wrist stability for *Pan* and *Gorilla*. We also show that although *Pongo* has an extremely unique mode of quadrumanous locomotion, it retains primitive radiocarpal characteristics that have disappeared in the African apes. This suggests the shared features of *Rudapithecus* and *Pongo* may represent functional similarities related to terrestrial fist-walking.

#### The functional influence on trait covariance in platyrrhine mandibles

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Covariance structure has important implications for understanding morphological adaptability. "Functional" models suggest there are two modular units in the mammalian mandible, the alveolus and ramus. I hypothesize that if function influences trait correlation, covariance should differ among primates with diverse diets. The following predictions were tested: 1) trait covariance is greater in the entire mandible, as well as within each functional module, in primate taxa displaying durophagous diets (*Cebus apella*, *Pithecia pithecia*) when compared to non-durophagous taxa (*Saimiri sciureus*, *Callicebus torquatus*); and 2) alveolar-ramal functional models accurately represent adult primate mandibular covariance.

Geometric morphometric techniques were applied to three-dimensional fixed and sliding semi-landmark data collected on an adult sample of platyrrhine mandibles (n=127). Pair-wise comparisons of covariance magnitudes between dietary groups were conducted using singular value decomposition scores. RV-coefficients were calculated to determine the best modular fit. All significance values are based on permutation tests.

Durophagous primates possess greater magnitudes of overall mandibular covariance compared to non-durophagous primates (p<0.001). However, when the alveolus and ramus were compared independently, only alveolar units displayed differences in covariance magnitudes (p<0.01) amongst dietary groups. This suggests that mandibular trait covariance is influenced by functional demands and the degree of covariance corresponds to that demand. Additionally, some modular units within the mandible (i.e. alveolus) are more susceptible to influence from external forces than others. Lastly, RV-coefficient results did not support the alveolar-ramal functional model. Thus, while function plays a critical role in determining mandibular covariance other factors, such as developmental processes, must also be considered.

#### Chimpanzee Foot and Ankle Joint Motion during Vertical Climbing

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Fossil hominin studies have used foot and ankle joint morphology to assess the prevalence of arboreal climbing in early hominins. Typically,

these studies compare fossil hominin joint morphology to that of great apes, which are known to climb trees frequently in the wild. However, the actual mechanics of great ape ankle and midfoot joints during climbing are still poorly understood. To address this gap, we measured the motion of these joints in chimpanzees during vertical climbing, and compared it to motion measured during terrestrial quadrupedalism.

We collected kinematic data from two male chimpanzees (*Pan troglodytes*) (7.4±0.1 yrs; 38.6±3.4 kg) using a four-camera motion capture system (ProCapture, Xcitex Inc.). We used a seventeen-point leg and foot marker set to measure three-dimensional motion at the ankle and midfoot joints. Subjects were recorded climbing a 15cm diameter tree trunk and walking quadrupedally on a flat runway.

Our results indicate that chimpanzees dorsiflex their talocrural joints slightly more during climbing than during terrestrial quadrupedalism. However, the actual difference is small enough to suggest to us that the high dorsiflexion range of the chimpanzee ankle may not be an adaptation for climbing. We also found that chimpanzees adopt highly inverted subtalar and transverse tarsal joints during climbing, suggesting that these joints may be better indicators of climbing proficiency than the talocrural joint. Finally, chimpanzees exhibit relatively high dorsiflexion angles at their tarsometatarsal joints during climbing, particularly on the medial side of the foot, suggesting that heightened mobility in this region may represent a climbing adaptation.

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#### Variable response of masticatory function on mandibular form

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Comparative studies of human populations have documented a predictable relationship between dietary variation and measures of mandibular size and robusticity. Recent work, however, has highlighted variability in form-function relationships in recent humans suggesting that the influence of function on mandibular form is not homogeneous across populations. To better understand variation in the morphological response to masticatory function, we examined two mouse models that exhibit baseline differences in mandibular cortical bone thickness. "Robust" (C3H/HeJ) and "gracile" (C57BL/6J) strains were both separated into hard-diet and soft-diet trial groups. The hard-diet trial groups were fed normal pelleted mouse chow, while the soft-diet trial groups were fed

## AAPA Abstracts

ground chow mixed with water. The experimental protocol began at 5 weeks of age and continued for 60 days. Using microCT images we assessed mandibular cortical bone area in the molar region and mandibular shape variation using geometric morphometric methods. The effects of dietary variation were evident in the robust mouse model. The hard-diet group exhibited relatively more cortical bone compared to the soft-diet group and there were considerable differences in mandibular shape between the groups associated with the morphology of the muscular processes. In contrast, the gracile mouse model trial groups did not exhibit any differences in mandibular cortical bone area or in mandibular shape. These results indicate that the skeletal response to mandibular loading is variable. With respect to human comparisons, this suggests that there may be important population differences in form-function relationships and that mandibular form may reflect loading history only in some comparisons.

#### Investigating the presence of mycobacterial pathogens in New World primates

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Tuberculosis and leprosy, caused by the *Mycobacterium tuberculosis* complex (MTBC) and *M. leprae* respectively, are age-old diseases that continue to affect human populations. The presence of animal reservoirs of these mycobacterial pathogens might explain their continued persistence among human populations due to a cycle of zoonotic transmission. Because of the increased contact and close evolutionary relationships between human and nonhuman primates, pathogens can be transmitted easily among them. Therefore, it is necessary to broadly survey nonhuman primate populations, including those in close proximity and distant to human populations, for the presence of mycobacteria. As a part of this study, a sample of 88 individuals, belonging to wild *Callithrix* populations in Brazil, were tested for the

presence of five specific mycobacterial genes using real-time polymerase chain reaction (qPCR) assays. Out of these, 19 individuals tested positive for the mycobacterial *rpoB* gene. Currently, we are developing a qPCR assay targeting the *hsp65* gene of a newly defined bacterium, *M. lepromatosis*, which is a sister taxon of *M. leprae* and causes a severe form of human leprosy in Costa Rica and Mexico. However, the exact geographic range and host range of *M. lepromatosis* are unknown. Furthermore, we are testing a sample of approximately 100 individuals, belonging to wild *Saguinus* populations from the Amazon region of Peru, for the presence of mycobacterial infection, using this set of qPCR assays.

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#### Individual contributions to pooled energy budgets: the Tsimane case

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The notion of humans as cooperative breeders—where individuals other than parents make net contributions to another's fitness—has gained increasing currency. The concept of pooled energy budgets captures the idea that resources are shared generally within co-resident groups. In this case, when resources are pooled and resources are re-allocated within groups according to relative need, production becomes effectively communal/communitarian. In this sense, pooled energy budgets can be considered as a public or common good. We use the case of the Tsimane of lowland Bolivia to evaluate the nature of this good, and its response to the productivity and need of members. We show that the network structure of net transfers of food is heterogeneous according to both donor and recipient characteristics. The heterogeneity of long-term net altruistic flows in these networks is patterned by the dynamics of production and consumption over the lifespan, an effect that is moderated entirely by consanguineous and affinal kinship. These results allow prediction of individual contributions to kin networks based on life stage and individual characteristics, including the productivity and need of self and family.

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#### Variation in regional diet and mandibular morphology in prehistoric Japanese hunter-gatherer-fishers

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Previous research has identified a relationship between mandibular morphology and diet (e.g., coarse diets result in more robust mandibles). Prehistoric Japan is an excellent place to explore the significance of this relationship in shaping mandibular morphology due to the pronounced regional dietary variation. South/West Honshu Jōmon engaged in broad spectrum foraging, Northeastern Honshu Jōmon were fisher-gatherers, Hokkaido Jōmon were maritime (sea mammal) foragers, and the immigrant Okhotsk maritime (sea mammal) foragers with some rice. We test the hypothesis that diet variation across temporal and spatial zones will be reflected in mandibular morphological traits. Metric measurements were utilized to test for regional differences with both archaeological time period and biological sex as covariants. ANOVA results for region with time period as a covariate indicated all variables except corpus height and breadth are significantly different among regions but for the time period covariate, significance is only present for corpus breadth and the dimensions of the ascending ramus. ANOVA for region with biological sex as a covariate indicates all variables except corpus height are significantly different. Biological sex as a covariate only rarely demonstrates significant p-values. Generally, North Hokkaido, followed by Southwest Hokkaido exhibit the largest mandibles whereas South/West Honshu have the smallest. Multivariate analysis indicates a separation between North Hokkaido and South/West Honshu. Differences in mandibular morphology are better explained by regional diets than by temporal trends and biological sex.

#### A case of severe hydrocephalus in a juvenile from the X-Group period of Sudanese Nubia (350-550 C.E.)

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A subadult cranium molecularly sexed as female and estimated to be 11 years old by dental eruption, was excavated from site 24I3 (350-550 C.E.) located along the Nile River across from the town of Wadi Halfa in the Republic of the Sudan. Analysis of the anatomical features led to several behavioral reconstructions, enabling the discussion of social behaviors surrounding disease and disability in ancient Nubia.

Cranial volume was measured at 1880cm<sup>3</sup>, over 61% larger than a healthy child matched for age. The cranium, visibly vascularized, appears triangular in shape due to extreme bossing at the parietal corners. The facial skeleton appears flat and minimized by the hyper-expanded vault, and metopism is observed. The oral region displays

evidence of tongue-thrusting and bruxing, habits associated with severe mental deficit. Malocclusion of the incisors is observed, and extensive calculus deposits are present on the posterior teeth. Cribrra orbitalia appears on the orbital roofs. The foramen magnum manifests as anteroposteriorly elongated and the nuchal lines are reduced, indicating poorly developed nuchal musculature. Postcranially, reductions in the anterior-posterior diameters of the long bones resulting from lack of extension and flexion movements indicate quadriplegia.

Paleopathological analysis indicates that this individual suffered from severe congenital hydrocephalus, which resulted in acute mental retardation, quadriplegia, and early death. This analysis offers the potential to understand wider anatomical and behavioral consequences of a debilitating condition, exploring the compassionate approach to disease and disability in this ancient Nubian population, including extensive social support for the ill and impaired.

#### **Tibial loading during walking and running in Late Pleistocene humans**

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Previous comparisons revealed no differences in adjusted bone strength between Late Pleistocene human groups which indicates similar loading from locomotor ranging behaviors. However, it remains unclear how other body shape and size parameters besides body mass and bone length affect bone loading. The main goal of the study is to account for the effect of limb proportions, muscle moment arms, and foot length on tibial loading during walking and running. We collected kinematic and vertical ground reaction force data for 49 adults walking and running and osteometric and tibial cross-sectional data for 51 Pleistocene and 18 Holocene adults. Peak bending moment and subperiosteal stress along the tibial shaft were estimated as sex-specific average for Neandertals, Middle Pleistocene modern humans (MPMH), and Early Upper Paleolithic humans (EUP), and for individuals from the Holocene sample using inverse dynamics and musculoskeletal modeling. Our results suggest that peak bending moments of Late Pleistocene and Holocene humans are of similar magnitude with the exception of MPMH males who has lower positive and higher negative peak moments close to or behind the margin of our Holocene sample variation. In peak subperiosteal stress Neandertals and MPMH cluster together around the lower margin of our Holocene sample variation whereas EUP cluster with the Holocene mean experiencing 18–39% higher stress than Neandertals and MPMH during walking and running. Thus, when accounting for lower limb configuration, tibia of Neandertals and MPMH seems to have been exposed to lower operational stresses than EUP

which questions previously suggested similarities in mobility.

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#### **Genome-wide DNA methylation variation in baboon bone and cartilage**

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Epigenetic regulation, including DNA methylation, can impact the development and maintenance of complex skeletal traits and thereby contribute to morphological diversity in primate evolution. Knowledge and appreciation of normal epigenetic variation in primates and skeletal tissues is a necessary first step towards understanding the role of epigenetics in the evolution of skeletal variation. We investigated the relationship between epigenetic variation and skeletal variation in one species and identified DNA methylation patterns in bone and cartilage from age- and sex-matched baboons, six with and six without knee osteoarthritis (OA). Genomic DNA was extracted from right distal femur bone (n=12) and cartilage samples (n=12), and genome-wide methylation was detected using the Illumina HumanMethylation 450K BeadChip. Several loci were significantly differentially methylated between normal and OA individuals, between bone and cartilage, and between the four groups based on tissue type and OA status. Specifically, out of over 450,000 positions, approximately 2.06% were differentially methylated between the OA and control groups, 1.94% between tissue types, and 1.32% among the four combinations of tissue type and OA status. From an evolutionary perspective, these results begin to give us an appreciation for normal methylation variation in one species and in two skeletal tissues. They also give us insight into the degree to which a common skeletal condition (OA) affects that variation. Expansion of this sample set and more focused testing of specific genes will advance our knowledge of the degree to which the epigenetic phenomenon of DNA methylation may regulate complex skeletal traits in primate evolution.

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#### **Comparing Preferred and Optimal Walking Speeds**

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Research indicates that for locomotor gaits, each individual has an optimal speed (i.e. the speed at which the energetic cost of transport (CoT) is lowest) and generally chooses to walk at or around this speed. We are interested in whether the ability to accurately choose an optimal speed changes when executing tasks of varying difficulty, in this case walking on an incline as compared to walking on the level.

Participants (n=5) walked at four different speeds on both a 12% incline and on the level. Separate CoT equations were calculated for the level and incline conditions; from these equations, the acuteness of the CoT curve (x2), the minimum cost of transport (MinCoT), and the speed at which the MinCoT occurred (SpMinCoT) were determined. Participants also chose the speed at which they preferred to walk. These preferred speeds were compared with the SpMinCoT. We found that the SpMinCoT for incline walking was on average 15.5% slower, the minCoT was 107% higher, and the optimality curve was 22.3% more acute. For level walking, the correlation between SpMinCoT and preferred speed was weak ( $R^2=0.001$ ), whereas for incline walking it was more robust ( $R^2 = 0.646$ ). Because of the curvature differences, the correlation between the minCoT and the preferred cost of transport was strong, though the relationship was stronger for incline walking ( $R^2=0.995$ ) than level walking ( $R^2=0.946$ ).

Accurately assessing the SpMinCoT can increase fitness by conserving energy for reproduction; these results show that people choose energy minimizing speeds, suggesting a fitness advantage.

#### **Women who deliver twins are more likely to smoke and have high frequencies of specific SNPs: results from a sample of African-American women who delivered pre-term, low birth weight babies**

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The purpose of this study is to examine if there are genetic and environmental differences between mothers of singleton and multiple pregnancies in a sample of African-American mothers. It is important to study twinning in



African-American women as they are expected to have higher frequencies of African-derived genes than more greatly European-derived counterparts in the USA, since African populations have some of the highest frequencies of twinning. We found significant interactions between smoking and SNPs of the CYP19A, MDM4, MTHFR and TP53 genes which result in higher odds of twinning. We also found a significant interaction between SNPs at the TP53 (rs8079544) and MTHFR gene (rs4846049), where the interaction between the homozygotes (TT for rs8079544, GG for rs4846049) lowered the odds of multiple pregnancy. We provide a mechanistic explanation for previous reports that mothers of twins are more likely to have smoked, despite seemingly conflicting evidence for the fertility-reducing effects of nicotine. Nicotine, as an aromatase inhibitor, inhibits estrogen synthesis and may allow for greater production of gonadotropins, which has been proposed to support polyovulation in cattle. While smoking may have deleterious effects on fertility across many genotypes, in women of specific genotypes it may raise their odds of producing twins.

**A test of the agreement between mitochondrial DNA and nuclear microsatellite based reconstructions of biological distance among regional populations**

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The present study examines the concordance between reconstructions of biological distance using nuclear microsatellite and mitochondrial DNA (mtDNA) data. This study revisits work by Sloan et al. (2002), which found that mtDNA was not as sensitive to differences among populations on a local scale (among neighboring villages). Further, genetic distances did not match expected relationships based on historical records. The present study examines how well each genetic dataset performs at a regional level, among more geographically disparate populations within coastal Kenya.

Twenty-nine microsatellite genotypes were compared with mitochondrial sequence data from the complete dloop (1121 bp) from 295 Kenyan individuals. These individuals comprise four populations (Mombasa, Lamu, Dawida, Kasigau) and two ethnic groups (Taita and Swahili). Biodistance matrices were constructed using a variety of statistics commonly used with microsatellite (e.g., Delta Mu) and mtDNA (e.g., phi-st) data.

Preliminary results from a sub-sample of the 295 individuals indicate that, while the nuclear microsatellite data could detect small differences

among the groups that reflected expectations based on expected historical relationships, the mtDNA data were not able to detect differences among the populations. One exception was a comparison of shared mtDNA haplotypes: differences could be detected between the two broader ethnic groups represented in the sample (i.e., Taita and Swahili) but not between populations from the same ethnic group (e.g., Mombasa and Lamu). These findings underscore the need for additional research into the utility of ancient mtDNA, which is commonly used in bioarchaeological contexts.

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**Age-Related Trends in Human Trabecular Bone Connectivity at the Cortical-Trabecular Interface in the Proximal Tibia Metaphysis**

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Ontogenetic studies on the weight-bearing bones of humans have revealed disparate developmental schedules for trabecular and cortical bone, suggesting both separate genetic control of skeletal growth and differential mechanical environments for the two structures. Developmental changes to bone microstructures at the cortical-trabecular junction (CTJ) remain completely unexamined but may possess key information about growing bone's mechanobiological maturation, particularly regarding compressive load transfer between metaphyseal trabeculae and the adjacent cortex. We assessed age- and position-related variation in trabecular connectivity density (Conn.D) in scaled cubic volumes of interest (VOIs) encompassing metaphyseal trabeculae that intersect the endocortical surface of the proximal tibia. Skeletal data were derived from high-resolution X-ray CT scans of subadult tibiae from the Norris Farms #36 Native American skeletal series (1300 CE). Trabecular VOIs (scaled by tibia breadth) for each specimen (n=44) were obtained from the center of the proximal metaphysis and the medial and lateral CTJ areas. VOIs were positioned with their centers located 5% of total bone length inferior to the proximal metaphysis margin. Conn.D was calculated using BoneJ and regressed against age; results were compared between VOI positions. Conn.D values decrease exponentially with increasing age (leveling out after late childhood) in all three VOI locations (R<sup>2</sup> values range from 0.82 to 0.94). This rapid, position-independent loss of connectivity following birth matches the overall decrease in trabecular

number and degree of anisotropy previously described for the tibia. Structures at the CTJ of the proximal tibia thus appear to exhibit ontogenetic properties most similar to those of metaphyseal trabeculae.

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**Neandertal / Modern Human Lineage Divergence Time**

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The time at which the lineages ancestral to Neandertals and extant humans diverged could initially only be estimated on the basis of fossil evidence. The oldest specimens displaying allegedly unique Neandertal anatomical features provide a *terminus ante quem* for this separation. However, assuming that Neandertal autapomorphies can be reliably identified in the earliest stage of their development, the estimation of this date has been much debated. The ages of several key middle Pleistocene sites have not been precisely established. Furthermore, the expression in the phenotype of visible Neandertal derived conditions clearly postdates the population split time and the genetic coalescence time of the two groups. The sequencing of the mitochondrial and later nuclear Neandertal genomes has allowed an independent computation of these parameters. Although genetic estimates initially provided age ranges that were barely compatible with the fossil record, a more consistent picture is gradually emerging. The ages of crucial fossil assemblages such as that of Sima de los Huesos (Spain) have been revised as well as the calibration of genetic coalescence trees that heavily relies on assumptions on the generation times in apes and ancient humans and on the mutation rates along different lineages. Discussions about the way to estimate these key parameters have recently resulted in a broadening of the possible age ranges for the separation time of the two lineages, making it more compatible with the current fossil and geochronological evidence. Elucidating this issue has important implications on the taxonomical interpretation of the Middle Pleistocene hominin fossil record.

**South American Dental Patterning: Assessment of the Sinodont and Sundont dental complexes**

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Christy Turner coined the terms Sundont (dental complex expressed by Southeast Asians) and Sinodont (dental complex exhibited by east and north Asians) to denote the two subdivisions



of the Asian complex. Turner argued that Northeast Asians migrated to the Americas during the Late Pleistocene. Thus all American populations exhibit trait frequencies representative of the Sinodont dental complex. However more recent research suggests larger geographic and temporal variation expressed among South Americans. Dental non-metric traits were explored to examine the extent to which South American series exhibit the Sinodont dental complex. The present study included samples from the following geographic areas: Brazil (n=129), Peru (n=54), Chile (n=10), Southeast (n=129), east and north Asia (n=104).

Results suggest some South American populations were found to exhibit trait frequencies aligned with Sinodonty, while others were not. Still other South American series express trait frequencies that are neither Sinodont nor Sundadont. The Peruvian and Chilean series seem to exhibit a more Sinodont complex, while the Brazilian samples express a larger number of Sundadont traits. The results of the morphological affinities analyses indicate differentiation among the South American series. The dichotomy between Sundadonty and Sinodonty does not fully describe dental variation in South America. In a sense, South American populations express traits that are close to either Sinodonty or Sundadonty, but there are also traits that are unique to South America. Thus, research should focus on the trait frequencies expressed among South American populations rather than on assigning them to Sundadont and Sinodont complexes.

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#### **A Multi-Component Analysis of Mexican Variation with Forensic Implications**

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A remarkable amount of genomic diversity among indigenous populations has been found in present-day Mexico. This diversity, coupled with regional variation in European admixture, provide a geographically structured genetic landscape. In the forensic context, understanding this variation can improve identification methods for US-Mexico border fatalities. In this study, we aim to reveal this geographic structure using the biological, CODIS (STR) and craniometric (ILD), markers relevant to forensic applications. Our previous work identified  $K=2$  cluster-model for both data types, supporting moderate differences between northern and southern regions of Mexico. Revealing stronger fine-

grained, microregional structure was potentially limited by the number of cases with known region of origin. Here, we greatly increase sampling depth with  $\approx 300$  unidentified border-death cases from PCOME and reference data for indigenous Maya and Mexican mestizos. Model-based cluster analyses of STRs and ILDs were performed with and without the reference samples to identify clusters capturing indigenous and mestizo variation.

We find, overall, that models with larger  $K$  values are preferred for the genetic data, suggesting that, when predictor numbers are similar, CODIS-STRs encode more structure than ILDs. In fact, ILDs fail to distinguish between Mexicans and Guatemalan Mayans. For STRs, our optimal  $K=5$  model allocates mestizos across two clusters and the unidentified PCOME cases into three clusters, of which at least one contains individuals with high indigenous ancestry ( $> 0.90$ ). Our clustering trends for the known Mexican cases recapitulate previous work, showing how Northern and Central cases cluster more frequently with mestizos, while the Southern cases do not.

#### **Non-specific indicators of stress and risk of mortality in industrializing London**

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Socioeconomic status is a prime determinant of morbidity and mortality in modern populations. Historical demographers have argued that this was not the case in industrial-era London, which suggests that modern day disparities are a relatively recent phenomenon. This study explores differences in morbidity and mortality between social strata in two adult skeletal samples from industrializing London (high status Chelsea Old Church and low status Lower Saint Bride's Churchyard). Chi-square tests are used to evaluate the distribution of non-specific indicators of stress (anemic lesions, skeletal inflammation, and dental enamel hypoplasia). The risk of mortality associated with the presence of these indicators is examined using the Cox proportional hazards model.

There are no significant differences in the distribution of non-specific indicators of stress between the upper and lower status samples. Non-specific indicators of stress are also unrelated to risk of mortality, with the exception of anemic lesions, which are associated with a significant increase in risk of mortality in the high status female cohort.

Results suggest that even when indicators of morbidity are proportionally distributed, the risk of mortality associated with any one indicator may still differ between socioeconomic strata. The presence of non-specific indicators of stress is not directly or consistently related to risk of mortality in all contexts. Bio-cultural

explanations for the increased risk of mortality associated with anemic lesions identified in the high status female cohort are discussed.

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#### **The integration of genetic and phenotypic data to better understand human and non-human primate limb morphology**

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Variation in human limb morphology results from complex interplay involving genetics, biomechanics, nutrition, and climate. Multiple studies show ecogeographic and clinal patterns in limb lengths and proportions and the action of evolutionary forces. The ways in which evolutionary processes shape these patterns are not well understood. The study presented here merges genotype and phenotype to investigate the genetic influences on morphology that may allow the evolution of human limb lengths and proportions.

Phenotypic and genetic variance, evolvability, and morphological integration between limb segments were examined in four large pedigreed samples (tamarins, two samples of baboons, and humans). Non-human primates serve as models for humans and allow for characterization of patterns of covariation among traits across related taxa. Results show variation in the relationship between limb segments across taxa. All species show higher covariance between homologous distal versus proximal limb segments. Humans show higher levels of evolvability and lower levels of integration relative to the other taxa, indicating that some aspects of limb morphology are stable across taxa, while humans are distinct in other aspects. Genotype data available for one baboon sample allowed for estimates of heritability (0.68 to 0.917,  $p < 1.1 \times 10^{-9}$ ) and identification of one significant and several suggestive quantitative trait loci (QTLs) – regions of the genome likely to harbor genes that influence variation in specific aspects of limb morphology. The results of these analyses are applied to develop a model of the processes that shape human limb length and proportion variation.

### **Experimentation of cut marks on bones: Reconstructing the force applied and type of weapon**

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Cut marks on bones are studied by both archaeologists and forensic anthropologists as they provide evidence of human activities, past and present. It is of interest to reconstruct the forces and tools/weapons' characteristics associated with cut marks. A device, specially constructed by the first author, was used to carry out this experiment on fresh pig forelimbs. The device allows alterations in the angle and mass of a pivoting arm 710mm long to which a weapon is attached, to produce the intended force of a cut. Two different knives were used; a smooth edged blade (cook's knife, mass =248g) and a serrated blade (bread knife, mass =185g) and four cuts were made per knife at two angles (90 and 45 degrees). Applying the two angles of movement, the forces were: Cooks knife 618.42N and 198.46N, respectively and bread knife 606.16N and 194.53N, respectively. A significant difference occurred between the two forces in length of flesh wound, (108mm and 75mm,  $p=0.002$ ), and bone cut length (29mm and 10mm,  $p=0.030$ ) for the cook's knife. The bread knife produced a significant difference between forces in the flesh wound length (113mm and 79mm,  $p=0.00015$ ), however not for the bone cut length. Differences occurred between the two knives in respect to the characteristics of the cut marks i.e. presence or absence of striations. The device can be manipulated to use different kinds of weapons and/or tools, forces and angles of attack, which can mimic different actions of hominins and criminals.

### **The Impact of Hierarchical and Gene Flow Processes on Patterns of Regional Genetic Diversity**

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The goal of this study is to measure the joint contributions of hierarchical and gene flow processes to patterns of regional genetic diversity. The data are from published sources and consist of 645 autosomal microsatellites genotypes from 5,418 individuals in 248 widespread populations. We use STRUCTURE and population trees to examine genetic structure and inter-regional admixture. We test the fit of the population trees to patterns of regional genetic diversity using generalized hierarchical modeling, and gauge the independent contributions of hierarchical and gene flow

processes using partial Mantel tests of gene identity, hierarchical structure, and geographic distance.

We find that hierarchical processes, local exchange, and inter-regional admixture all contribute to patterns of regional diversity. Hierarchical processes play the dominant role in all regions except East Asia, where gene flow accounts for 50% of the variation compared to 30% for hierarchical structure. However, gene flow accounts for less than 35% of the variation in other regions and none of the variation in Central Asia and the Americas. The secondary role of gene flow outside of East Asia may reflect the disproportionate number of isolated foraging and horticultural populations in the sample. We also find that interregional admixture obscures hierarchical structure within regions, but that its effects are mitigated when the sources of admixture are excluded from analysis. We consider the implications of our findings for sampling strategies in studies of regional evolution, the long-standing debate about the role of clusters vs. clines in human evolution, and the non-existence of biological races.

### **Postcraniometric databank for the Robert J. Terry Collection: On-line access, data sharing, and discussion for measurement standardization**

DAVID R. HUNT and DANIEL L. DIMICHELE. Department of Anthropology, Smithsonian Institution.

The Robert J Terry Anatomical Skeletal Collection is comprised of 1728 individuals with known demographic information. To provide digital access for some of this collection, a postcranial osteometric database containing 400 individuals has been assembled using standard measurements. This database is accessible online to researchers through the Smithsonian Anthropology website. Intra- and inter-observer error was checked for consistency and accuracy of the values.

During the assessment of measurements from past researchers, we found discrepancies in values, produced mostly from how the measurement was taken. Positioning of bone, interpretation of osteometric definition, measurement technique, and research goal of the researcher all affected the resulting measurement.

It is apparent that there needs to be further discussion on osteometric standardization to decrease error in the various methods, especially in measurements with the same name but different definitions. Certain measurements need to be changed or eliminated -such as: Ulna AP and ML diameter (resulted in an intraobserver error correlation of 0.41 and 0.65, respectively). Measurements should be designed to capture the

morphological characteristics of an element and/or be applicable on a population level to highlight the variation of the element. To be specifically presented are what postcraniometrics are the most inaccurate or variable, including -subtrochanteric diameter, tibia nutrient foramen position, and AP or ML diameters of the clavicle, tibia, and the ulna.

With the ongoing data collecting for the Terry Collection databank, clarified standardization for osteometric data can be shared with confidence in accuracy of comparable measurements with other databanks.

### **Intracortical porosity of the distal radius: association with evidence of systemic remodeling**

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Distal radius fractures are a common ailment following trauma whether during growth, at peak bone mass, or as a result of decreasing bone quality. Assessment of the integrity of cortical bone in the distal third of the radius has been used to inform fracture risk in the human population throughout advancing age. This study examined distal radii and sixth rib midshaft samples from ten males ranging from 59 to 100 years old (mean 81.1 years) to investigate the effects of systemic remodeling on the porosity of the distal radius. Intracortical porosity was measured manually for each radius and rib by including all Haversian systems, resorption spaces, and Volkmann's canals. To normalize by size, percent cortical porosity (%Po.Ar) for each element was calculated by dividing the total porosity area by the cortical area (Po.Ar/Ct.Ar). Percent absolute cortical area (%Ct.Ar) was calculated as a measure of intracortical porosity by dividing the absolute cortical area (Ct.Ar-Po.Ar) by the total subperiosteal area (Tt.Ar). Both %Po.Ar and %Ct.Ar in the radius were predicted by age ( $p=0.01$  and  $p=0.046$ , respectively). However, it does not appear that systemic remodeling as assessed in the rib can predict the amount of remodeling and thus porosity in the cortex of the distal radius in this sample ( $p=0.077$ ). This suggests that although the radius undergoes changes with increasing age, these changes cannot be predicted by an often utilized indicator of systemic bone metabolism (i.e. the rib).

### **The New and the Old in Hominid Brain Evolution, Part II: Why Paleoneurology Needs a Chimpanzee Brain Atlas**

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Paleoneurology is hampered by the lack of a chimpanzee brain atlas based on a proper sample size. Here we present such an atlas, and discuss variability in chimpanzee frontal lobe morphology as well as implications of this variability for the study of hominin endocasts. We will provide evidence, contra Connolly (1950), that a middle frontal sulcus is not rare in chimpanzees, and therefore frequent occurrence of this in australopith endocasts (Falk, 2014) cannot be evidence of an evolved trait. We will also discuss broadening of the frontal lobes in australopiths, the probable locations of the medial and inferior frontal sulci on the endocast of MH1, evidence of plastic deformation on the orbitofrontal surface of MH1, and the implications of this deformation for the morphology of its inferior frontal gyri.

**Between continuity and discontinuity: an overview of the West African Paleolithic over 200,000 years**

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In comparison with the archaeological richness of the eastern and southern parts of the continent, the West African Palaeolithic has remained largely unknown until recently. Despite its relation to the Sahara and relevance to the major issues of Palaeolithic north-south mobility, survey of this area has been quite scanty. However, during the last century, much Palaeolithic evidence (ESA to LSA) was recognized by researchers, suggesting early human occupations for at least 200,000 years. Unfortunately, these finds were surface finds or not in situ and never dated, although inaccurate chronological information was sometimes presented. Thus, a good chronostratigraphic framework and detailed description of the different cultural complexes were lacking. Thanks to international research programs since the 2000s, new important and valuable data has been obtained from different areas, from such sites at Ounjougou in Mali, along the Faleme River in Senegal, or in northern Ghana around Birimi. These show a more intricate cultural history, between continuity and discontinuity, than a simple series of traditions. Consequently, knowledge of the West African Palaeolithic (and more broadly in Africa) has been enriched and significantly contributes to key questions currently being addressed: the expansion and mobility of modern humans, the emergence and

**development of techniques, and chronological gaps and hiatus in the cultural history.**

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Reconsidering the high mandibular condyle of robust australopiths

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Years ago, Smith and Savage (1959) suggested that high mandibular condyles of herbivores are more mechanically efficient than are low-positioned condyles because the high condyle is linked to larger jaw-closing moments of the masseter and medial pterygoid muscles during chewing. Others, including Rak and Hylander (2008), have considered additional competing hypotheses regarding condylar position, with a particular emphasis on robust australopiths. My purpose here is not to review competing hypotheses for condylar position. Instead, I'll focus on observations regarding maximum gape data for baboons and geladas (Hylander, 2013), and these observations are relevant for why robust australopiths have highly positioned mandibular condyles.

It is well known that baboons have low-positioned condyles, whereas geladas have high-positioned condyles. Following Smith and Savage, high condyles are presumably linked to larger muscle-moments and bite force, whereas low condyles are linked to smaller muscle-moments and bite force. Importantly, and all things considered equal, larger moment arms should be associated with less gape, whereas smaller ones should be associated with more gape.

Surprisingly, relative gape (maximum gape/projected jaw length) in baboons and geladas are near identical. Values for male and female baboons and geladas are as follows: *Papio anubis* 1.12 and 0.87, *Papio hamadryas* 1.03 and 0.86, and *Theropithecus gelada* 1.05 and 0.90, respectively. Contrary to expectations, relative gape values (for each sex separately) are more or less identical. Thus, these data do not support the hypothesis that high condyles in robust australopiths are necessarily linked to increased muscle-moments and bite force.

**Diet and Nutritional Health among Cassava Producing Agriculturalists of East Java**

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Research from the 1960 and 1970s documented high levels of malnutrition and small adult body size among rural populations of Java (Bailey, 1961, Edmundson, 1972, 1977). Since then, there has been little subsequent work to explore whether nutritional circumstances have improved over the last 40-50 years. This paper investigates patterns of dietary consumption, and measures of nutritional status in a sample of 84 men and 113 women (18-80 years) from the rural agricultural society Ngilo-Ilo, East Java. Mean daily energy intakes are modest, averaging 1374 kcal/day in men and 1026 kcal/day in women. The primary energy source is carbohydrates, contributing 75% of calories, compared to 12% for fat, and 13% for protein. These macronutrient proportions and dietary patterns are remarkably similar to those documented by Edmundson in three agriculturalist villages in East Java four decades ago (1972). Protein intakes are lower than WHO recommendations, averaging 36g/day in men and 27g/day in women. Both men and women had inadequate intakes of calcium, zinc and iron, but consumed adequate levels of vitamin C and vitamin A. The average male BMI in 1970s was 20.6 kg/m<sup>2</sup> (157cm height/ 50.9kg weight), comparable to the mean of 20.5 kg/m<sup>2</sup> (159.8cm height and 51.6kg weight) for men of this study. These findings indicate that undernutrition remains a major problem in east Java, and that agrarian reform of the 1970s did not help improve the plight of small-scale rural farmers.

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**Kojo's (Dis)ability: Interpreting Impairment in an 18th Century Jamaican Maroon Community**

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More than three centuries ago, a group of self-emancipated African-Jamaicans, referred to as Maroons, selected a man named Kojo as their leader. Although Kojo is among the most famous and historically best-documented African-Jamaicans of his time, little is known about his physical appearance. Based on one somewhat-vague primary source and one illustrated secondary source, 19th and 20th century writers generally accepted that Kojo was "hunchbacked" (i.e., his spine was abnormally kyphotic). More recent scholarship has challenged this interpretation, claiming that Kojo's deformity was not corporeal, but rather rhetorical—nothing more than a posthumous colonial effort to disfigure an otherwise indomitable adversary. However, when viewed through the lens of critical disability theory, little compelling ethno-historic evidence can be found to substantiate the assumption that, if Kojo did indeed have a visible body difference, like kyphosis, such a condition would have necessarily disqualified him from holding the chief Maroon leadership position. To the contrary, special marked status



## AAPA Abstracts

may have actually enabled Kojo to assume power. Thus, it is suggested that, in this specific context, scholars have traditionally failed to account for the role of cultural creativity in the social construction of disability and alternate ability. More broadly, it is argued that without this type of careful and culturally specific contextualization, bioarchaeologists run the risk of conflating impairment and disability.

**Behavioral comparisons with peers for a young adult female chimpanzee (*Pan troglodytes*) following application of sensory integration therapy**

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The Holly Project was initiated in 2009 to investigate and address atypical behavioral patterns in a young adult female chimpanzee (*Pan troglodytes*) at the Saint Louis Zoo. Holly initially presented with a range of stereotypies, restricted social interactions, lack of rest times and poor occupational performance in routine activities. Holly's abnormal behavior resulted in social isolation and affected group dynamics, for example through avoidance behavior. A therapeutic intervention (TI) plan for Holly, developed utilizing human sensory integration theory, was implemented during 2010 and 2011. Periodic monitoring of Holly's activities using interval sampling of focal individuals continued, allowing examination of changes in behavior.

Comparative data were also collected on Holly's peers within her social group. Pre-TI, Holly differed from her peers in almost every behavioral category, notably stereotypic behavior, social grooming, and social proximity. Post-TI, Holly's stereotypic behaviors and time alone decreased, while social grooming increased. More than 2 years post-TI, Holly's behavioral profile showed sustained improvements relative to pre-TI, but still differed from her peers. Relative to them, Holly was groomed less, still had higher rates of stereotypies and spent double the time alone. While Holly engaged in more social grooming than her peers at this point, she had fewer different social partners. Interpreting these continued differences is complex. Individual maturity, personality, changes in the social group, and the TI Holly received, are likely contributors to the quantitative differences. Qualitatively, Holly appeared to be less distressed and more integrated into her social group than when the project began.

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**Skeletal diagnosis of multiple diseases in an European juvenile**

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Differential diagnosis of tuberculosis (TB) and venereal syphilis may be difficult as various infections produce similar responses and no skeletal signs are clearly pathognomonic. In contrast to venereal infection, congenital syphilis has distinctive features facilitating a diagnosis. A case study of remains of a juvenile European settler (probably male, 8-10 years old) (B70) buried in the 19<sup>th</sup> century and excavated in 2000 from the cemetery of the Anglican Church of St. Marys in South Australia is presented. B70 demonstrated that two diseases may have been present at the same time, TB and congenital syphilis. Widespread destruction of vertebral bodies and kyphosis-related rib deformations indicate advanced TB. Severe dental hypoplasia is limited to permanent incisors and first molars, there is pitting on the palate, periosteal reaction on the skull vault and thinned clavicles. Signs were compared to clinically diagnosed cases of congenital syphilis in living children and to archaeological specimens indicating that B70 had congenital syphilis and possible TB. B70 has mixed dentition. Dental signs are not limited to "screwdriver" central incisors and mulberry molars. Apical portions of the crowns of permanent upper, lower, central and lateral incisors have multiple hypoplastic disorganized defects, deciduous canines have severely hypoplastic crowns while possibly hypoplastic occlusal surfaces of lower deciduous second molars are largely destroyed by extensive caries. This indicates that dental pathognomonic signs of congenital syphilis described by Hutchinson and Moon may have moved beyond the upper central incisors and mulberry molars. The findings described may be helpful in future palaeopathological diagnoses.

**Functional constraints of primate feeding: Modeling the effect of ligaments and TMJ morphology**

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The movement of the mandible with respect to the cranium during feeding is the result of the interaction of active mechanisms (e.g., muscle activation patterns and muscle dynamics), and passive mechanisms (e.g., morphology of jaw joint, elastic and inertial properties of muscles, occlusal morphology). The relative importance of these passive mechanisms, however, is not clear and is often overlooked with respect to active mechanisms. In a previous study, we have shown that the axis of rotation of the mandible, a measure of jaw movement, changes through the gape cycle and the overall location of this axis varies among individuals and species, but it is consistent within an individual. In this study we explore the effect of ligaments and articular morphology on determining the movement of the mandible during feeding. We used 3D models of both cranium and mandible of three species of primates (*Papio*, *Macaca*, *Cebus*). The potential range of mandible positions were modeled by randomly rotating and translating the mandible with respect to the cranium. To constrain the model we used the length of mandibular ligaments (i.e., sphenomandibular, stylomandibular, and temporomandibular) as well as the posterior band of the TMJ, measured from dissections, as well as avoiding the 3D surfaces of the cranium and mandible to overlap. We found little evidence that ligaments drive mandible movement (with the exception of the extreme adduction or protrusion). In contrast, jaw joint and occlusal morphology have larger effects in determining mandible position during feeding.

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**Who were they really? Model-free and model-bound dental nonmetric analyses to affirm "known" population affiliations of seven South African "Bantu" samples**

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When using biodistance analyses in bioarchaeology, it is common practice to *assume* that pre-modern skeletal samples are representative of the populations to which they are attributed. This study is somewhat contrary, in that recent samples of *known* attribution in the Raymond A. Dart Collection are analysed to assess their value as proxies for pre-modern peoples. Specifically, do Ndebele, Sotho, Swazi, Tswana, Venda, Xhosa, and Zulu "Bantu" samples in the Collection best reflect past, or recent, patterns of population structure? Moreover, although not explicitly stated, many researchers believe that past curation and collection issues make these sample attributions suspect. Thus, model-free and model-bound methods were used to quantify whether these synchronic samples (n=408 individuals) can be used to yield credible diachronic estimates of population affinity and history.



First, among-sample D2 and mean measure of divergence distances based on 36 and 22 dental nonmetric traits were obtained to compare against documented population relationships. Next, the Mantel test was employed to evaluate fit of the isolation-by-distance model between phenetic and geographic distance matrices; the latter are derived from historic locations of each "Bantu" group's South African homeland. Finally, R Matrices and minimum and estimated Fst (0.021-0.038) calculated from the phenetic distances provide some indication of genetic micro-differentiation. Results suggest that of all seven samples, only Ndebele and Swazi do not seem representative of their attributed pre-modern populations. Whether related to collection issues, recent swamping of past genetic structure, or both – it appears that neither sample is suitable for population history study.

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#### Together in solitude: Sifakas and bamboo lemurs cycle through food patches rapidly and rarely share

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Socioecology seeks to explain the evolution of social organization by modeling it as an adaptation to spatiotemporal distribution of foods. A fundamental assumption is that increasing group size causes increased feeding competition; this has been documented in several species. However, one variable that many studies overlook is the degree to which food patches are shared by groupmates. We used day-long focal animal follows to quantify patch use and sharing in two lemur species at Tsinjoarivo, Madagascar. Diademed sifakas (*Propithecus diadema*) visited 37.2 feeding patches per day, with average bout duration of 232s (n=363 days). For four adults in 2 groups (each with 1 adult male and 1 adult female), 15.8% of bouts were in patches shared with the other adult (17.2% of feeding time), and most sharing was sequential, not simultaneous (n=8 days). Bamboo lemurs (*Hapalemur griseus*) had shorter bouts (213s; n=133 days). Within a 4-member group, 64% of the adult female's feeding time and 84% of the adult male's was in

patches not shared by groupmates (n=8 days). Lemurs (especially adults) seem to be "isolated within groups" during feeding. This raises questions for understanding optimum group size; if group-mates find similar-quality patches, the relationship between patch size and group spread may be less important than the ranging costs associated with larger groups (scramble competition). However, if similar patches are not found, steeper within-group fitness gradients may result. Much remains unknown about interspecific variation in patch-sharing; understanding these differences might help explain variation in social adaptations, including unique lemur traits.

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#### The potential role of nonadaptive evolutionary mechanisms shaping color vision in red-bellied lemurs (*Eulemur rubriventer*)

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Color vision variation in primates is an oft-cited example of simple molecular mechanisms (changes in opsin proteins) underlying important phenotypic evolution (modified foraging success). Although research on color vision has largely focused on adaptive explanations, nonadaptive explanations have also been proposed, and it remains unclear why some species have trichromatic or polymorphic color vision while other closely-related species are red-green colorblind. Lemuriforms, in particular, are highly variable. While some species are polymorphic, many lemurs are strictly dichromatic, usually exhibiting only the medium wavelength opsin.

In this study, we characterized opsin variation in a wild population of red-bellied lemurs (*Eulemur rubriventer*) in Ranomafana National Park (RNP). We sequenced exon 5 of the X-linked opsin gene for 86 lemurs ( $N_{X \text{ chromosomes}} = 132$ ) and identified opsin spectral sensitivity based on known diagnostic sites. Results indicate that the frequency of the long wavelength opsin allele is 100%. The fixation of this long allele is in contrast to previously published accounts of captive *Eulemur* species exhibiting either polymorphic color vision or only the medium wavelength opsin allele. This result may represent directional selection favoring the long allele or allele loss due to drift. In order to address the latter hypothesis, we genotyped 51 adult red-bellied lemurs at six variable

microsatellite loci and assessed heterozygosity excess as an indicator of a recent population bottleneck. Initial results indicate that the RNP red-bellied lemur population may have experienced a recent population bottleneck. These results emphasize the need to consider nonadaptive mechanisms of color vision evolution in primates.

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#### Unpacking proximate mechanisms of cooperation: The role of oxytocin and other hormones in meat sharing among Tsimane' hunters

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While ultimate explanations of cooperation such as kin selection or reciprocal altruism are well studied, we are only beginning to understand the underlying proximate mechanisms. Here we focus on the roles of oxytocin, testosterone and cortisol in motivating cooperation. Oxytocin is best known for its role in mother-infant and pair bonds across mammals, but recent studies have shown that oxytocin was associated with cooperative behavior across diverse relationships including non-kin cooperation partners. Importantly, oxytocin levels during social interactions track relationship quality and may thus function as a score-keeping mechanism and to motivate cooperation with valued partners. As such, oxytocin could be responsible for overcoming the fight-or-flight and stress responses triggered by testosterone and cortisol and thereby enable cooperation, especially when stakes are high. In order to test this hypothesis, we measured salivary hormone levels collected from 31 Tsimane men during hunting and food provisioning, an ancient form of high-stakes cooperation in our species. Oxytocin showed a significant increase when hunters returned home compared to baseline (W=20, P<0.01), with changes in oxytocin levels closely tracking testosterone and cortisol levels. The amount of meat brought home (Beta=0.65) and a hunter's number of children (Beta=0.27) had positive effects on oxytocin change, controlling for age, bmi, polygyny, testosterone change, and whether the hunter was satisfied with the hunt. These findings tentatively support the hypothesis that oxytocin interacts with testosterone and cortisol to facilitate high-stakes cooperation. We discuss our results in light of existing theory and highlight future directions.

### Differential diagnosis of a calcified object from Meroitic Al Khiday 2, Central Sudan

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Calcified objects are occasionally reported in studies of skeletonized and mummified human remains from archaeological contexts, particularly from ancient Egypt. Most of these findings have been identified as arterial calcifications, associated with cardiovascular disease (CVD) such as atherosclerosis. Here we discuss a tortuous, elongated calcified object found in the thoracic region of an elderly (36-45 years) male individual (Sk119) from Al Khiday 2, Central Sudan. The skeleton dates to the later Meroitic period (1<sup>st</sup> century BCE – 3<sup>rd</sup> century CE) and belongs to a small (n=43) sample of Meroitic individuals excavated at the multi-phase cemetery of Al Khiday 2.

The irregularly shaped tubular object measures 39 mm in length, but both ends are broken post-mortem; its width varies between 2-4 mm. Radiographic analysis confirmed that the object is hollow inside without any visible trabecular structure. The cortical bone is smooth and of varying thickness. A differential diagnosis of circumferentially calcified blood vessel, calcified Guinea worm and ossified stylo-hyoid chain with post-mortem displacement is made. Based on the location within the body and its overall macroscopic and microscopic appearance, we propose that this object could be a calcified blood vessel. We discuss potential risk factors such as diet, air pollution, chronic infectious disease and dental disease that could have led to the development of CVD in skeleton 119. This finding should add to the growing body of literature on calcified objects and will further increase our understanding of cardiovascular disease in the past.

### Effects of perceived work stress on circadian patterns of ambulatory blood pressure variation are influenced by ethnicity among working women

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Studies have shown that reported stress perception at work and home influence ambulatory blood pressures (BP) in women such that those perceiving more stress at work (WS) have higher circadian BP than those perceiving more stress at home (HS). However, few if any studies have evaluated whether there are ethnic differences in how stress perception affects BP variation. The purpose of this study was to compare the circadian patterns of variation in systolic (SP), diastolic (DP) and pulse (PP)

pressure and heart rate (HR) between European-American (EA) ((WS) N=32; age=35.5+8.9; (HS) N=16; age=34.4+10.1) and African-American (AA) ((WS) N=14; 35.5+6.7; (HS) N=15; 32.6+7.5) women who perceived greater stress either at work or home. All the women worked in clerical or technical positions at a major medical center in NYC. BPs and HRs were measured from 9AM to 6AM the following day, and averages were calculated and compared for each hour. Stress perception at work and home was evaluated on a scale from 0 (low) to 10. WS and HS were determined from the difference between the work and home scales. Ethnicity and stress effects were evaluated using ANOVA models. Among EAs, WS women had higher SP and PP than HS women for most hours (p<.05), but no differences in DP or HR. Conversely, among AAs, there were no differences between WS and HS women. Overall, AAs generally had higher HRs than EAs (p<.05). These findings suggest that perceived stress at work has a greater impact on BP among EA women.

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### First evidence of Nyanzapithecinae at Moroto II, Uganda

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The Nyanzapithecinae is an enigmatic group of catarrhines of uncertain affinity that until recently was comprised solely of taxa from early and middle Miocene sites in Kenya. Recently, their range has been extended into the Oligocene with the report from a new taxon, *Rukwapithecus* from Rukwa, Tanzania (25.2 Ma). Here we report on yet another occurrence of a nyanzapithecine, at the early Miocene sites of Moroto II in Uganda (>20.6 Ma). The Moroto nyanzapithecine is represented by an isolated and well-preserved lower third molar. Like the molars of other members of the subfamily, it has relatively narrow crown proportions. Within the Nyanzapithecinae, it appears most similar to *Rukwapithecus* and the early Miocene *Rangwapithecus* (Kenya, ~19 Ma), sharing: a buccolingually broad distal fovea, a well-developed buccal cingulid that surrounds the base of the protoconid mesially and defines a broad distobuccal fovea distally, and the presence of complex, extensive occlusal crenulations. However, the Moroto II M<sub>3</sub> also possesses a unique mix of characters that do not readily ally it with either *Rukwapithecus* or *Rangwapithecus*, combining the absence of a prominent crest joining the hypoconulid and entoconid with a narrow hypoflexid, a buccal cingulid that does not merge onto the hypoconid, and lacking a prominent lingual indentation between the mesial and distal cusps. Overall, the specimen is more similar to *Rangwapithecus* than to *Rukwapithecus*, to whom it is also closer

in age. The specimen increases the known taxonomic diversity of the Nyanzapithecinae and provides the first evidence of the subfamily at Moroto II.

### Is there structure in the Euro-American population?: Evidence from cranial morphology

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The Euro-American population is normally seen as lacking significant structure because old European ethnicities play virtually no role in mate choice. However, different European ethnicities tended to settle in different regions of the country, Italians in the Northeast, Germans in the Midwest and English in the South. This paper examines whether the spatial distribution of ethnicities is detectable in cranial morphology.

Since its inception in the mid 1980s, the Forensic Anthropology Data Bank has collected metric data from identified forensic cases. It also contains metric data from the Bass Donated Collection. Birth state was recoded into one of nine U.S. census subregions. For each state, the number of main immigrant groups (German, English, Irish, and Italian) was expressed as a proportion of the total White population for each state. Sample size was approximately 600. The median birth year is 1944, and three quarters of the sample was born before 1960. Mahalanobis distances and canonical variates were used to search for variation among subregions and canonical correlation was used to test the hypothesis that the variation could be attributed to ethnic composition of each state.

Variation among subregions was significant and showed New England and Pacific coast states to be the most differentiated from each other and from other subregions. Although variation among subregions is significant, it is low. Canonical correlation shows that the main axis of variation separates areas with high frequencies of Germans from those with high frequencies of other ethnicities.

### Adaptation to terrestrial bipedalism and 5<sup>th</sup> metatarsal structural properties in *Australopithecus* and early *Homo*

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Hominin 5<sup>th</sup> metatarsals (Mc5) demonstrate that increased calcaneocuboid stability, including a stable lateral column of the foot, probably emerged early during the adoption of obligate terrestrial bipedalism. Despite reported variability in morphological characteristics found in South African and East African hominin Mc5, they support development of a longitudinal arch, and are more similar to each other, than elements that form the medial column of the foot. Here we evaluate the potential for conservatism in the function of the lateral column. Specifically, we test whether the Mc5 diaphysis of *Australopithecus* and Early *Homo* are similar to one another, and also whether they are more similar to modern humans than apes.

Mc5 of chimpanzees, gorillas, modern humans, and hominin fossils from Sterkfontein, Swartkrans and Dmanisi, were CT scanned. For each metatarsal, we measured 17 cross sections from 35% to 75% of diaphyseal length. In each cross section, we measured thickness of the diaphyseal wall radially at one degree increments. Cortical bone thicknesses (CBT), as well as second moments of area (SMA) were size-standardized, after which they were subjected to a penalised discriminant analysis (PDA) to assess extant species-specific and fossil patterns.

Fossil Mc5s appear to have greater CBT, but very similar SMA to modern humans. This suggests human-like functional loading of the lateral column of the foot in the fossil hominins in this sample. The reduction of cortical bone seen in modern humans could be following the evolutionary trend toward gracility in bone morphology, as is generally seen in other mammalian clades.

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**A genetic link to trade-offs between reproduction and lifespan: polymorphism of interleukin-10 gene and fertility of women**

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Reproduction and lifespan may be linked due to existence of genes that benefit reproduction but reduce lifespan (antagonistic pleiotropy). Ageing is characterized by pro-inflammatory status which increases the risk of age-related diseases. Therefore, genetic variation in inflammatory cytokines may be correlated with ageing and longevity. Gene IL-10 (encoding interleukin-10 with strong anti-inflammatory function) is suggested as one of the longevity genes. Simultaneously, such gene, through its documented involvement in regulation of

immune function, may have a pleiotropic effect on reproduction. We show that IL-10 indeed antagonistically affects women's fertility.

We studied relationship between polymorphism of gene IL-10 and fertility among 175 post-menopausal Polish women in a rural population at the Mogielica Human Ecology Study Site. Women who were AA homozygotes had significantly higher number of children (4.8 v. 4.2,  $p = 0.048$ ) and sons (2.7 v. 2.2,  $p = 0.04$ ) than AG or GG genotypes. Higher parity AA women had also much shorter average interbirth intervals (33.8 v. 44.5 months,  $p = 0.01$ ).

Higher fertility of women with AA IL-10 genotypes could be explained through a role that IL-10 plays in maternal immuno-tolerance of the fetus or in regulation of the HPA axis. Our results suggest that IL-10 gene has antagonistic pleiotropic effects: genotypes that are known to have a lower risk of many old age diseases also have reduced fertility. This provides evidence of a genetically-based trade-off between immune function and reproduction in women.

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**Association of immune variation with exploratory behavior and neuroendocrine responses to stress in vervet monkeys**

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The immune system not only defends against infectious diseases, it is also a critical modulator of the behavioral processes of the host. However, the genetic, molecular mechanisms that underlie immune influences on behavior are poorly understood.

To understand how the immune system shapes behavioral variation, we propose leveraging the sabaeus vervet monkey (*Chlorocebus aethiops sabaesus*) whose immune system displays a dichotomy—i.e. two distinctive patterns of T-lymphocyte subsets based on the expression of CD4 and CD8a molecules in blood, referred to as the “CD4CD8 dimorphism” with A and B phenotypic variants. The CD4CD8 phenotype is stable across ontogenic development and irrespective of environmental conditions.

We tested associations between A and B variants of the CD4CD8 phenotype and traits related to behavior in sabaeus vervets of Caribbean-origin in The Vervet Research Colony (VRC). We

observed that increased psychological stress causes a significant increase in long-term cortisol levels both in A and B individuals; however, this cortisol stress-responsivity is more than three-fold lower in individuals with the B phenotype than in individuals with the A phenotype ( $p < 0.028$ , T-test), which suggests a greater resilience to stress in B individuals. Moreover, novelty-seeking scores and stress-response indicators that represent a tendency to exploratory and impulsive behavior, are significantly higher in B individuals than in A individuals ( $p < 0.04$ ).

These findings suggest that the CD4CD8 immune phenotype influences behavior in vervets. Further work with this model has the potential to elucidate the molecular mechanism and genetic basis of immune contributions to behavior.

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**Resting postures in human evolution: squatting, sitting, and the biomechanics of low back pain**

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In many contemporary cultures, people do not rest in chairs, but instead rest in squatting and floor-sitting postures. These “traditional” styles of rest appear in the hominin fossil record in the form of squatting facets on the distal tibia as early as 1.8 mya, suggesting chair-sitting is a relatively recent form of inactivity. Low back pain (LBP) is a common health problem linked with sitting in Western contexts, but is less prevalent among populations that rest in traditional postures. This study examines the link between rest and LBP by comparing back function in different resting postures. Based on recent work linking LBP with muscular atrophy of the erector spinae (ES), we hypothesized that traditional postures would elicit a more kyphotic lumbar curve and higher levels of ES activity, which could limit atrophy over time. Lumbar angle and ES activity were measured in ten subjects during periods of chair-sitting, floor-sitting, and squatting. Paired t-tests were used to compare variables between conditions. All sitting styles resulted in a kyphotic curvature of the lumbar spine. However, squatting elicited higher levels of ES activity than chair-sitting ( $p = 0.0156$ ;  $0.0078$ ) which may help to keep the ES well-conditioned. In contrast, lower muscle activity during chair-sitting may cause atrophy of the ES over time, increasing vulnerability to LBP. Ultimately, these differences in muscle activity may help to explain the current cultural patterning of LBP. Since this study only included Western subjects, future work will examine lower back biomechanics in subjects who are experienced at squatting.



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### Parallel trajectories of genetic and linguistic admixture in Cape Verde

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Major human migrations during the last several hundred years have generated new populations of joint European and African ancestry. The Cape Verdean archipelago, located near the western coast of Africa, provides one of the earliest examples of this admixture phenomenon, in which interbreeding among Europeans and Africans since the late 1400s led to a complex pattern of genetic, linguistic, and cultural variation. To study linguistic and genetic variation on Cape Verde, we investigated patterns of genetic and linguistic diversity among 44 unrelated Cape Verdean individuals. Genetic data consisted of genotypes at ~2.5 million genome-wide SNPs and linguistic data of spontaneous speech in Cape Verdean Creole (Kriolu) provided by each subject. We found that individual speech patterns across Cape Verdean Kriolu speakers were significantly correlated with pairwise levels of allele-sharing dissimilarities, as well as with the birthplaces of individuals and their parents. Individual levels of African genetic admixture were significantly positively correlated with the number of words of putative African origin used by each individual. These results suggest that genetic and linguistic admixture followed parallel evolutionary trajectories in the Cape Verdean archipelago, and they provide a basis for combining genetic and linguistic information to reconstruct the complex admixture processes that have shaped the cultural and biological diversity of Cape Verde. To our knowledge, this work is the first joint analysis of genetic and cultural variation within a single population of individuals sharing a common, mutually intelligible language.

### The spatial distribution of lacuno-canalicular system within the tibial cross section shows its sensitivity to the mechanical loading

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There is an ongoing discussion, whether the morphology and spatial distribution of lacuno-canalicular system (LCS) give us any information about the mechanical loading history. However, only limited data about spatial distribution of LCS within the cross section is available. The aim of this study was to analyze and compare the LCS parameters of entire cross section in Lurcher mutant mice (Lc) and healthy controls. LC mouse represents a natural model of genetically determined motor disorder, causing significant differences in locomotion.

Using mid-diaphyseal transverse sections of tibia, we analyzed 800 lacunae within entire cross sections of 4 B6CBA mice (2 Lc mice and 2 healthy controls). To localize the lacunae, each cross section was divided into smaller regions, according to the anatomical orientation (anterior, posterior, medial and lateral), and axes of moments of area ( $I_{max}$ ,  $I_{min}$ ).

Our results show, that the mean value of canaliculi number per lacuna is significantly higher ( $P < 0.05$ ) in Lc mice in region  $I_{max\_anterior}$  (by 16.70 %),  $I_{min\_lateral}$  (by 27.82 %),  $I_{min\_medial}$  (by 23.24 %) and insignificantly higher in  $I_{max\_posterior}$  (by 3.03 %), compared to the healthy controls. The lacunae of Lc mice have also significantly higher ( $P < 0.05$ ) mean number of canaliculi in periosteal (by 7.32 %), intermediate (by 28.65 %) and endosteal (by 19.22 %) regions. Our results show significant differences in spatial distribution of LCS within the cross section between motor disorder group and healthy control, and probably indicate, that LCS is affected by mechanical loading.

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### The role of genetic correlation in papionin facial evolution

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At least two large-scale changes in body size and facial projection characterize papionin evolution. The clade encompasses macaques and two additional lineages, each containing at least one large-bodied, sexually dimorphic, extremely prognathic taxon and at least one small-bodied, sexually monomorphic, less prognathic taxon. The key to understanding these trends is identifying genetic correlations underlying

phenotypic variation and ascertaining how such correlations bias evolutionary trajectories. Studying papionins augments hominin evolution research, as changes in relative degree of facial projection have also occurred extensively in hominins and there is increasing evidence that genetic correlations are largely conserved between related taxa. Two genetic covariance matrices for measurements characterizing size and shape variation in the papionin face and cranial base were estimated from baboons (N=985) and macaques (N=210) using 27 3D coordinate landmarks. The macaque covariance structure showed overall low levels of association among traits while that of the baboon demonstrated strong signals of morphological integration. These same traits were measured in other papionin genera (*Cercocebus*, *Lophocebus*, *Mandrillus*, *Theropithecus*) to create taxon-specific phenotypic covariance matrices. Multiple evolutionary models were fit to the data using maximum likelihood estimation and those incorporating selection for either allometry or sexual dimorphism in body size fit the data better than ecomorphological or neutral models. The clade's most likely ancestral state is a cranium most similar in shape and size to that of a Rhesus macaque. This is the first analysis of craniofacial evolution in catarrhines to directly incorporate estimates of genetic correlations for multiple taxa.

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### Scanning electronic microscopy analysis on intentionally modified teeth

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Recent excavation on the, remote South Atlantic island of St Helena uncovered skeletal remains of 325 individuals buried in the Liberated African Graveyard. The graveyard was in use while the Liberated African Establishment operated on the island during the British suppression of the transatlantic slave trade in the middle of the 19th century. Bioarchaeological analysis of the remains has revealed the largest assemblage of African dental modification found in an archaeological context, consisting of more than hundred individuals. These intentionally modified teeth are distinctive because of their symmetric appearance and the deliberate patterns formed with two or more teeth. In this study, replicas of the modified teeth were analysed in scanning electronic microscopy in order to identify the ways in which the modification was created and to explore if there is a difference in the age and sex distribution of modification methods. Likewise, the difference between patterns was explored. For SEM analysis the replicas were mounted in a brass disc and sputter coated with gold and observed at 100 X and 500 X magnifications. Overall there seem to have been some distinction in methods used to produce various patterns and marks left by



several tools were identified. Furthermore there was some difference between sex and age groups. Studying how the dental modifications were created can give us insight into this cultural practise existing in Africa during the era of the slave trade.

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#### **A Bioinformatics Pipeline for Identifying Heat Shock Protein 70 (HSP70) Gene Family Duplications in Tapeworms to Study Hominin Dietary Evolution**

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Tapeworms have a complex life history, requiring a larval phase in an intermediate host (often an herbivore) and an adult phase in a definitive carnivorous host. The carnivore becomes infected with adult tapeworms after consuming cysts in under- or uncooked tissue of the intermediate host. A recently published genome sequence of the human-specific tapeworm species *Taenia solium* contained a large number of annotated copies of the HSP70 gene family (n=32). HSPs aid protein-folding processes during conditions of environmental stress. We hypothesize that HSP70 duplications may have been adaptive for human tapeworms to withstand higher heat stresses associated with food cooking behaviors. To begin testing this hypothesis, we used the Illumina HiSeq 2500 to collect >30-fold whole genome sequence data for individuals from the 3 human tapeworm species (*T. solium*, *T. saginata*, & *T. asiatica*) as well as from ~10 other species within the *Taenia* genus to compare the quantity of HSP gene duplications among species and estimate the dates of any lineage-specific expansions. The sequence read data were analyzed with a novel, in-house bioinformatics pipeline designed to identify HSP genes and estimate the number of duplications, even in the absence of annotated genome assemblies. Here we present the pipeline for this bioinformatics tool and demonstrate its utility through its application to our multi-species *Taenia* tapeworm genome sequence dataset. This pipeline, which will be made publically available, can be similarly applied to other non-model species and gene families and thus be useful for testing many evolutionary hypotheses with genomic sequence data.

#### **A multi-joint case of avascular necrosis in a prehistoric Native American female**

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Differential diagnoses can be used to identify the causes of osseous defects that affected individuals prior to death. In this study, we present the remains of a Native American female from the Campbell site (23PM5), a Late Mississippian site (1540-1650 A.D.), who exhibits multifocal osseous deformities affecting most notably the left hip, as well as the left shoulder, elbow, and the right wrist joints. The remains were examined macroscopically, microscopically, and radiographically and a differential diagnosis was performed on the hip as it was the most dramatically affected joint. Inclusive pathological conditions and disease processes affecting the hip, which include slipped capital epiphysis, cerebral palsy, developmental dysplasia, and Legg-Calves-Perthes disease (LCPD), were included in the differential diagnosis. This individual exhibits characteristics most consistent with an avascular necrosis syndrome resulting from an unknown cause. The multifocal distribution of the osseous defects suggests a systemic disease process. Radiographic analysis of the proximal femoral hip joint support the descriptive diagnosis. While there is not a diagnostic signature of the avascular necrosis that would help discriminate it from other conditions, it may suggest that the individual could have suffered from LCPD. This would be unusual, as LCPD is an uncommon disease, particularly among females (20%) and Native American populations, but may support the idea of LCPD being related to systemic factors that may affect multiple joints.

#### **Assessing the Life History of Potential Trophy Heads in the Middle Woodland Period: Isotopic Analysis of Human Remains from the Elizabeth Site (11PK512) in the Lower Illinois River Valley**

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A wealth of research exists on the Lower Illinois River Valley (LIRV) of the American Midwest detailing human occupation spanning from the Archaic through the Mississippian periods (6000 B.C.- A.D. 1300). However, evidence points to a period of human absence between c.a. 200-50 B.C., after which clear shifts in material culture and burial mound construction suggest recolonization by new populations. During this reoccupation, six skulls were interred in an invasive slot trench in Mound 3 of the Elizabeth Site, an anomalous act of unknown circumstances. This study employs multi-isotopic analyses to estimate residential origins and mobility within the LIRV, in particular to test competing hypotheses that these skulls

represent captured members of a geographically non-local group, or local individuals subjected to atypical mortuary treatment. This study therefore aims to situate this unique occurrence within the broader context of LIRV cultural identities.

This study presents results of strontium and oxygen isotopic analyses of bone and tooth enamel carbonate from these skulls (N=6) and from individuals interred in traditional burials (N=9), all from Mound 3. These paired tissue samples respectively preserve isotopic values from local geology and water in early life and late life, permitting intra-individual comparisons and elucidating changes in residence during an individual's lifetime. Preliminary results of both <sup>87</sup>Sr/<sup>86</sup>Sr and  $\delta^{18}$ O data indicate both inter- and intra-individual variation, suggesting changes in immigration patterns and further clarifying the demographic variation at this site during a period of heightened mobility and cultural change.

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#### **The Changing Spatial Pattern of Low and Very Low Birthweight in the United States, 1972-2008**

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Low birthweight (LBW) arising from pre-term birth is a major source of morbidity and mortality worldwide. Nearly one in eight births in the United States is pre-term and the rate of pre-term birth has increased 31% between 1981-2008. The pervasive difficulty of the problem of LBW arises in part from our fundamental lack of understanding of the specific etiological mechanisms that underlie pre-term labor. Birthweight is a highly complex phenotype, affected by a variety of genetic, physiological, and socioeconomic factors. Our goal is to identify broad trends in the distribution of birthweight which might suggest etiological hypotheses.

Using birth certificate data from the United States from 1972-2006, we reveal a number of striking patterns in LBW and very low birthweight (VLBW) in the US. Despite heterogeneity in changing demography and socioeconomic status across states, all measures of the birthweight distribution have changed in concert over the study period. This change is well-explained by simple shifted model that is quadratic in time and stratified by race. The first principal component of different measures of the race-stratified, state-by-year birthweight distributions (e.g., mean, variance, proportions LBW/VLSW) explains at least 93% of the variation in the data. The spatial pattern of birthweight has changed substantially over 35

years, with a striking south-southwest migration of the growth of both black and white LDW/VLBW over the period. Finally, we present the results of a novel wavelet-based spatial clustering measure which allows us to characterize LBW/VLBW according to its joint periodic and spatial correlations.

#### Identifying Recent Migrants to a Revolutionary War-era Charleston Slave Cemetery using oxygen isotopes

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From the initiation of the slave trade, the port at Charleston, South Carolina, became a primary destination for half of all slaves sent to the United States. This preliminary study investigates evidence for recent migration to the Charleston area through analysis of oxygen isotopes from cortical bone from 26 individuals. The burials were excavated from a Revolutionary War-era cemetery dated between 1690-1750, an early period in the international slave trade. Metric and morphological assessments of intact material identified all individuals as Black with 3 being further refined as consistent with African origins.

Contemporaneous faunal samples established a local baseline with mean  $\delta^{18}\text{O}$  carbonate (VSMOW) = 25.5‰ ± 0.6 (2  $\sigma$ ).  $\delta^{18}\text{O}$  range for human bones was 21.9‰ to 26.2‰ with a mean of 25.1‰. A hierarchical cluster analysis using Ward's method produced two clusters. An independent-samples t-test was run to analyze significant differences in  $\delta^{18}\text{O}$  values. The group 1 cluster (25.73‰ ± 0.32) contained 17 individuals and was within ±0.23‰ of the local baseline. The group 2 cluster (23.84‰ ± 0.53) contained 8 individuals and was significantly lower by an average of 1.65‰ than group 1 (95% CI, 1.31 to 2.1),  $t(23) = 9.083, p < .0005$ . The data suggests that 17 of the 26 individuals had lived in Charleston for a number of years sufficient for the ratio in the cortical bone to shift to the local signal while the remaining 8 individuals may be been more recent migrants. Analysis of tooth enamel is underway to confirm these findings.

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#### Evaluation of mastoid process as a sex indicator using geometric morphometrics

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The purpose of this research is to evaluate mastoid process as a sex indicator by separating the effect of its size and shape using geometric morphometrics. For this, the right side of mastoid processes of 100 males and 100 females from the W. M. Bass Donated Skeletal Collection of the University of Tennessee was photographed from a lateral perspective and 30 semi-landmarks were digitized using the Makefan7 between the porion and the end point of incisura mastoidea. Based on the centroid size or shape of mastoid process, a discriminant function was generated for each using SPSS 18 and Morpho J 1.05e. And MANCOVA with the centroid size and sex factor was performed using the partial warp scores calculated by tpsRegr.

The results showed that the discriminant function based on the centroid size and shape of mastoid process was significant separately ( $p < 0.001$ ). However, the effect of centroid size and sex on the shape of mastoid process was also significant ( $p < 0.001$ ). And there was no significant difference in the effect of size on shape in both sexes ( $P=0.961$ ). In addition, 87.26% of the total variance was explained by the centroid size factor and 12.74% by the sex factor. Meanwhile, females tended to have a broader and shorter mastoid shape than males, regardless of its size. These results indicate that the size and shape of mastoid process are valid sex indicators, though the shape of mastoid process is largely influenced by its size.

#### New hominin fossils from Ileret (Kolom Odiet), Kenya

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Field expeditions in 2012-2013 to the Turkana Basin, Kenya, under the aegis of the Koobi Fora Research Project, recovered new hominin fossils from two sites in the Kolom Odiet area near Ileret. Three individuals are represented: a nearly complete mandibular dentition (KNM-ER 64060), and two partial skeletons (KNM-ER 64061 and KNM-ER 64062). KNM-ER 64060 and 64061 are dated to 2.02-2.03 Ma, and KNM-ER 64062 dates to 1.82-1.86 Ma. All teeth except the right central incisor are preserved in KNM-ER 64060, which is attributed to the genus *Homo* on the basis of morphology and metrics. KNM-ER 64061 preserves most of both humeral diaphyses, a nearly complete right ulna, much of the right clavicle, a right scapular glenoid, and numerous other fragments. The long bones are relatively gracile but possess thick cortices in cross-section. KNM-ER 64062 preserves a distal

humerus, a left scaphoid and a partial right foot that includes a calcaneus, talus, cuboid, navicular, intermediate and lateral cuneiforms, the hallux metatarsal and its proximal phalanx, and parts of the four lesser metatarsals. The scaphoid resembles those of other early hominins (e.g., STW 618, LB 1). The foot bones display a mix of primitive and derived features. The hallux and talus are similar to those from Dmanisi; the navicular sports a large tuberosity and is pinched laterally. The calcaneus has an inflated tuber with both plantar processes and – like the cuboid – is modern in appearance. Overall, the morphologies of KNM-ER 64061 and KNM-ER 64062 suggest they both represent early *Homo*.

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#### The effect of age on body mass estimation using the stature/bi-iliac method

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The stature/bi-iliac breadth method provides reasonably precise, skeletal frame size (SFS) based body mass (BM) estimations. In this study, we examine the effects of age changes in stature, bi-iliac breadth, body mass and body composition on this "morphometric" method's estimation precision in light of anthropometric data from the literature, as well as our skeletal data.

As a general rule, lean body mass (LBM) increases through adolescence and early adulthood until the 30s or 40s and starts to decline in the late 40s or early 50s. Fat mass (FM) tends to increase until the mid-50s and declines thereafter, but in highly mobile traditional societies it may decline throughout adult life. Because BM is the sum of LBM and FM, it exhibits a curvilinear age-related pattern in all societies.

SFS based on stature and bi-iliac breadth tends to increase significantly throughout adult life in both skeletal and anthropometric samples because age-related increase in bi-iliac breadth more than compensates for age-related stature decline commencing in the 30s or 40s. Combined with the above-mentioned curvilinear BM change, this results in curvilinear estimation bias. BM of youngest and oldest individuals is the

smallest relative to the SFS, but that in their midlife is the largest. Overestimation of BM at both extremes of the age range and underestimation in the middle of the age range is possible. This estimation bias should be taken into account to achieve as precise individual BM estimations as possible.

#### Identifying genetic associations with central adiposity in Hispanic subgroups: the HCHS/SOL Study

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Central obesity is a leading public health concern and its prevalence has more than doubled since the 1980s, with the greatest burden carried by minority populations, particularly Hispanic/Latinos (HL). Emerging evidence suggests that genetic factors contribute to the obesity burden overall and to population-specific differences. We aim to 1) identify novel loci associated with waist to hip ratio adjusted for BMI (WHR<sup>a</sup>), a relative comparison of central adiposity after accounting for overall body size, using the Hispanic Community Health Survey (HCHS/SOL Study; 2) determine if previously identified WHR<sup>a</sup> associated variants generalize to the HL population.

Our analyses included 7,472 women and 5,199 men of Mexican, Central and South American, and Caribbean origin residing in the US, genotyped on the Illumina SoL Omni2.5M array, imputed to the 1000 genomes Phase I Reference panel. Due to the established differences in genetic effects on WHR between males and females, we analyzed sex-specific associations for WHR<sup>a</sup> using linear mixed model regression, assuming an additive genetic model, adjusted for age, age<sup>2</sup>, study center, sample weights, population structure, and relatedness. We identified one novel locus ( $p=1.2E-8$ ) near *PLEKHG4B* for men and one for women near *NTM* ( $P=4.3E-8$ ). Of the 48 established WHR<sup>a</sup> loci, 38 SNPs displayed a directionally consistent association and 18 were nominally significant. Three loci (near *VEGFA*, *GRB14-COBLI1*, and *LY86*) displayed statistically significant evidence of association after Bonferroni correction ( $p<0.001$ ). These observations highlight the importance of large-scale genomic studies in ancestrally diverse populations for identifying obesity-susceptibility loci that generalize and those that are ancestry-specific.

#### Overview of Sensory Systems of Tarsius

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As the sister taxon to anthropoid primates, the brains of tarsiers are of special interest to those interested in types of brain evolution in primates. We studied the histological features of sensory systems of tarsiers (*Tarsius spectrum*) primarily from three brains obtained from an Indonesian Primate Center as part of another study. Brain sections were processed for neurons, myelin, cytochrome oxidase (CO), or the calcium binding proteins. The well-differentiated visual system has long been recognized as the most remarkable feature of the tarsier brain. Most notably primary visual cortex (area 17) occupies proportionately more of neocortex than in any other primate, and cortical layers and sublayers of area 17 are more clearly defined than in any other primate. Such a large visual area would be important in mediating detailed vision, and the differentiated layers and sublayers reflect functional specializations within area 17. Possibly, tarsiers depend more on area 17, and less on extrastriate visual areas than other primates. The tarsier lateral geniculate nucleus conforms to the basic 4-layered anthropoid pattern, with the addition of a broader interlaminar zone of small neurons that reflects a specialization for nocturnal vision. The auditory and somatosensory systems of tarsiers do not appear to be as highly specialized as the visual system.

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#### BADaBooM – a New Database Solution for Bioarchaeology

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Following the publication of the *Standards for data collection from human skeletal remains* in 1994, an accompanying database, the *Standard Osteological Database (SOD)* was developed by the Arkansas Archaeological Survey in MS-DOS/FoxPro, superseded by the Smithsonian Institution's *Osteoware* when MS-DOS became outdated. Though a number of other larger database projects for human skeletal remains exist, *Osteoware* is currently the only database that is also available as a download for individual use, albeit as a stand-alone application with no access to source code, and thus with no possibility of customization. To that end, I developed the Bio-Archaeological Database Module (BADaBooM) as part of my dissertation, with the aim of eventually making it available to others. The database is mainly modeled after *Standards* and *Osteoware*, with some additions,

chief among which are the data screens for archaeological context information and small finds registries, which are not offered by *Osteoware*. BADaBooM was developed in Filemaker 13, and is available either as an fmp.12 file with full access privileges, meaning that anyone with the Filemaker 13 program can customize the database for personal use, or as a stand-alone runtime solution not requiring the Filemaker program, but without the ability for customization. The full database is cross-platform (OS X or Windows), and is also compatible with IOS through the use of FilemakerGo. An iPad version of the database for field data collection is currently under development. This presentation will demonstrate the main features of the database, along with information on how to obtain it.

#### Does relative pituitary gland size predict mammal life history?

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Life history traits vary noticeably across and within species and are influenced by a variety of ultimate and proximate factors. At the proximate level, a variety of hormones are known to play a critical role in influencing the behavior and life history of mammals, including humans. Hormones are produced from multiple glands in the body. The pituitary gland is directly responsible for producing several hormones, including those related to growth and reproduction. Although we have a basic understanding of how hormones affect life history characteristics, we still have little knowledge of this relationship in an evolutionary context. Here, we used data from 136 mammal species representing 14 orders to investigate relationships between pituitary gland size and life history variation. Because pituitary gland size should be related to hormone production and action, we predicted that species with relatively large pituitaries should be associated with increased fetal and postnatal growth rates, as well as reduced longevity. Phylogenetic comparative analyses controlling for brain and body mass revealed that total pituitary size, as well as the size of the anterior lobe of the pituitary, significantly predicted mammal fetal and postnatal growth rates, but not maximum longevity. This is some of the first evidence that the size of a brain structure, the pituitary, is linked to life history variation through mediating hormone levels. In addition, we demonstrate that data related to endocrine gland size may be critical for fully understanding life history evolution.



### Interpreting physical impairment in the Mississippian Period: A case study from the Holliston Mills Site, TN

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Physical impairment, a limitation of the physical function of limbs, joints, and motor ability, resulting from a wide variety of pathological processes, can manifest on the body in a variety of distinctive, identifiable ways. However, translating this into disability, which reflects an interaction between features of the body and an individual's social context, is complex and culturally contingent. Embedding pathological data into contextual archaeological evidence within an interpretive framework generated from social theory on disability can go some distance towards crossing this divide. Here, we apply this approach to estimate the disability experienced by an individual recovered from the Mississippian period Holliston Mills Site (ca. A.D. 1360-1550) in Upper East Tennessee. The individual, an adult female, exhibits lesions specific to and suggestive of treponemal disease on multiple postcranial elements, as well as activity markers and postcranial skeletal deformities suggestive of chronic physical impairment associated with the treponemal lesions. Analysis of the mortuary patterning of the individual burial in relation to other burials at the site (N=660) however, suggests no spatial segregation of the burial or variance in distribution of the artifacts recovered with the individual. This case study contributes to a growing body of literature on disability in paleopathology, and expands scholarship on the functional costs of treponemal disease while demonstrating some of the possibilities and limitations of reconstructing disability in prehistoric contexts.

### Dietary preference, feeding behavior, and sociality among female Diana monkeys (*Cercopithecus diana*)

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Though female Diana monkeys (*Cercopithecus diana*) engage in coalitional intergroup aggression and have relatively high levels of intragroup aggression compared to sympatric, congeneric taxa, the relationship between feeding behavior and sociality has not been examined. Socioecological models suggest high quality foods (e.g., mature fruit) should elicit competitive, aggressive interactions between females. Here, I test this model by combining data on Diana monkey food preference and selectivity with data collected in 2013-2014 on

the relationship between feeding behavior, and sociality among females from two groups ranging in Tai Forest, Cote d'Ivoire.

Diana monkeys are ripe fruit specialists, consuming nearly 75% fruit annually. Mature fruit of *Sacoglottis gabonensis* has the highest selectivity index (L=0.17) and comprises the greatest proportion (24%) of consumed foods. These trees are both numerous (n=131) and large (mean DBH=50.3 cm), comprising 7% of groups' home ranges' total basal area. Mature fruit of *Dialium aubrevillei* has the next highest selectivity index (L=0.14) and comprises the next greatest dietary component (14%), but only 0.7% of groups' home ranges' total basal area; though comparably sized, *D. aubrevillei* trees are much rarer (mean DBH=51.33, n=13).

The socioecological model predicts competition should be more intense at rare, frequently selected *D. aubrevillei* trees than *S. gabonensis* trees. Nevertheless, direct aggression between females was never observed at either tree species. Moreover, while consuming one of these resource, females were observed within 5m of another adult female during 65% of observations. However, incorporating data on ingestion rate, preference, and rank may illuminate hidden dietary inequalities among females.

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### Sexual dimorphism of the femur in an Austrian population from the 19<sup>th</sup> and 20<sup>th</sup> century

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Osteometric investigations of femora offer an opportunity to study the sexual dimorphism in human populations in context with regional specifics.

This current study focused on three main determinants: *i*) the distance in femoral dimensions of Austrian males and females; *ii*) comparison of sexual dimorphism data of the Austrians with those found in other European, South African, and North American white populations; and *iii*) correlation between sexual dimorphisms, and classification rate for (cross-validated) discriminant analysis of single dimensions.

Three defined dimensions on the femora of 69 female and 53 male adults were measured. The following absolute distances (D) and relative

distances (*r*D) between the weighted means (*w*M) of both sexes were obtained: Maximum length D=35.8mm (*r*D=8.3%); maximum head diameter D=4.9mm (*r*D=11.1%); and condylar width D=7.6mm (*r*D=10.1%). In comparison, the corresponding data extracted from sixteen femora studies on different populations published previously were as following: maximum length from 6.6% to 9.7% (*w*M=8.2%); maximum head diameter 11.1% to 16.3% (*w*M=14.1%); and condylar width 8.6% to 14.2% (*w*M=12.1%). Comparative analysis of these data sets revealed for the Austrian femora a relatively higher sexual dimorphism in the length of the femora; a lower degree of sexual of the head diameter; and a lower sexual dimorphism for the condylar width. Expectedly, a highly significant correlation between the investigated femur dimensions (*r*=0.807; *p*<0.001) was found between *r*D and classification rates for the pooled data set.

The established sexual dimorphism may prove helpful for sexing Austrian subjects based on diagnostic evaluation of skeletal remains in a forensic context.

### eAnthro: Community engagement in developing online learning resources

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Online learning resources first became available as soon as the web came online, with early materials often mirroring the sorts of elements that instructors used in their classrooms. We found the web to be the perfect medium for producing virtual libraries of materials that otherwise were not easily available to the community of diverse K-Grey learners. For example, our initial efforts included eSkeletons.org, a site of primate skeletons that combines color images, 3D movies, animations, and interactive overlays; and eLucy.org, a site about a particular fossil that is presented in a rich comparative context that includes educational materials and lesson plans. Future websites must be cognizant of the facts that the range of materials is now beyond what any one team can author, and that engaged users can also be contributors. We built the collaborative website, eFossils.org, that incorporates various data from human evolution (e.g., anatomy, geology, geography, geochronology) within a multimedia learning environment (e.g., color images, 3D animations, video) and offers a series of online tools to visually represent these data and permit their study. The eFossils catalog uses the Darwin Core schema and permits the display and mapping of data sets from any project. The



website also includes a “collaboratorium,” a web tool built on a generic template that permits the research community to collaborate on large-scale problems, and all of our websites are bundled under eAnthro.org. Users who assist in building the websites become the owners, and their investment ensures sustainability and vitality.

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#### **Stable isotope analysis of incremental sections of human dentin from Malawi (20<sup>th</sup> and 21<sup>st</sup> ct. AD)**

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Using data collected from the remains of six adult males of Bantu origin from sub-Saharan Africa with known life history derived from the University of Malawi College of Medicine, this project examines the effects of historically-documented stressors that impacted Malawi's food security during the 20<sup>th</sup> and 21<sup>st</sup> century on stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotopes in dentin collagen from permanent teeth. Individuals were selected based on year of birth. Transverse microsampling of dentin collagen (n=156) from a mandibular first molar and a mandibular second molar from each individual provides evidence of stable isotope variation from birth to approximately 14 years. Each tooth produced 11 to 15 transverse sections, and each individual generated between 23 and 28 total microsamples.  $\delta^{13}\text{C}$  bulk hydroxyapatite from dental enamel and bone provides comparative data for whole diet for each individual.  $\delta^{15}\text{N}$  values range from +7.0 to +11.3‰, suggesting that 83% of the sample population (5/6) exhibits a weaning signal in the first molar. All six individuals exhibit intra-tooth  $\delta^{15}\text{N}$  fluctuations in the range of +1 to +2‰ that are consistent with natural variation. In 50% of the sample population (3/6),  $\delta^{13}\text{C}$  values are approximately 2‰ less positive in dentin microsamples formed concurrent with or subsequent to documented stressors. Possible environmental, climatological, physiological, and social factors are discussed in an effort to explain the observed shifts. This study highlights the variability in the resolution of stressors observed at a regional level in incrementally-deposited, non-remodeling biological tissues formed during childhood.

#### **Modularity and covariation in extant human occipital growth**

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Extreme convexity of the occipital squama, often called occipital bunning, is a feature common to Neandertals, as well as some early modern and extant humans. While often noted as “present” or “absent” in anatomical descriptions, little is known about the timing and developmental patterning of this feature. This study uses geometric morphometric methods to quantify the ontogenetic development of occipital squama convexity in a longitudinal sample of extant humans.

The sample for this study includes lateral radiographs of 37 subjects (22 males, 15 females). To ensure the inclusion of relatively rare occipital bun morphology, the extremes of variation in adult occipital squama shape were targeted. In total, 12 landmarks and 42 sliding semi-landmarks were digitized along the midsagittal profile of each subject at 3 age groups (3.0-6.0 years, 8.0-10.0 years, and 15.9-19.8 years). Escoufier's RV coefficient, which evaluates between-module covariance relative to within-module covariance, was used to assess modularity between midsagittal occipital shape and other aspects of cranial morphology.

Significant covariation was found between occipital shape and cranial base angle, with more obtuse cranial base angles found in crania with more convex occipital squamae. This result fits observations of Neandertal crania, which are known to have less flexed cranial bases and more prominent occipital buns than extant humans. Additional results suggest that the frontoparietal and occipital regions do not covary significantly, suggesting that cranial height and overall neurocranial midline shape are not causative factors leading to occipital squama convexity.

*This study was made possible by use of material from the American Association of Orthodontists Foundation (AAOF) Craniofacial Growth Legacy Collection.*

#### **A New Method for Estimating the Relationship Between Surface Area and Volume in the Human Body**

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A new model for studying the relationship between surface area and volume was created using skeletal data from the Goldman

Osteometric Dataset. The model, which is tentatively referred to as the “Tin Man”, shows very strong correlations with both anthropometrically-derived surface area ( $r = 0.92$ ) and body mass ( $r = 0.79$ ), and outperforms the cylindrical model in both aspects. The “Tin Man” incorporates both lower and upper limb length, crural index, and body width and, thus, allows for the examination of how these components of size and shape affect the body's overall surface area to volume ratio when transitioning from one (presumed) climate-adapted form (e.g., narrow body, long-limbs, high crural index) to another (e.g., wide-body, short-limbs, low crural index). This was tested by creating an average “cold-adapted” and “heat-adapted” person, and manipulating the “heat-adapted” form to the “cold-adapted” one. In congruence with the work of Ruff, the results show that body width, which can be viewed as an extension of Bergmann's “rule”, has a large effect on the body's overall surface area to volume ratio. The results also show that morphologies associated with Allen's “rule”, such as limb lengths and especially the crural index, have a minor effect, which calls into question whether or not they are climatic adaptation, at least as it pertains to surface area to volume ratios.

#### **Beyond the Mantel test: phylogenetic mixed models and human cranial form as a multivariate response**

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Attempts to quantify the extent to which morphological divergence among groups is due to neutral processes, selection, and environmental effects face a number of challenges. The partial Mantel test and phylogenetic mixed model (PMM) are two commonly used solutions. While the Mantel test has positive attributes, such as the ability to process multivariate observations, it has important weaknesses as well. Chief among these, the method only retrieves estimates of association among matrices of pairwise distances; it does not provide estimates of effect size and error in the original units of measurement. PMMs scale up quantitative genetic methods for pedigreed observations to inter- and intraspecies contexts. In contrast to Mantel tests, PMMs are designed to partition phenotypic variance among fixed and random effects. However, most PMM implementations are restricted to studies involving just a few variables, hence few parameters. Here, we apply recent innovations that extend the PMM to highly multivariate data. Our Bayesian mixed model uses an embedded factor model to estimate the phylogenetic effects matrix, the PMM analog to additive genetic effects. This simplifies the problem by reducing the number of parameters to be estimated. Using 57 linear measurements on 10 populations from the

Howells craniometric data set, we replicate a previously published analysis of the relative influence of population history and climate on modern human cranial variation. Our preliminary results indicate that both population history and climate influence cranial form, though population history effects are much stronger. Most encouraging, the factor model readily accommodates the high-dimensional data set.

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#### Field Courses for Non-Majors

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Engaging students in general education science courses presents many challenges. Often, students enrolled in these courses are focused only on meeting graduation requirements and may not have any interest in the subject itself. Here I share two case studies of field-based general education science courses which increased student engagement and contributed to the students leaving the course with a more positive view of science. Through descriptions of the courses and comments made by the students enrolled, I demonstrate how specific characteristics of these field-based courses increased student engagement through their use of inquiry-based learning, the formation of a learning community via travel, the use of independent work requiring self-determination and high expectations from the instructor. These are all variables that previous research has found to be essential to motivation in general education courses. Through this preliminary descriptive work on which further research will be based, I present a first demonstration of the possible usefulness of field courses in a general education program, and some lessons for other educators who may want to develop field courses for non-science majors.

#### Ancient Mitochondrial DNA Analysis of the Roman/Parthian Period Cemetery at the Site of Tall Šeh Hamad, Syria

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The site of Tall Šeh Hamad presents a unique opportunity to conduct genetic analysis of a distinct mortuary population dating to the Roman/Parthian period (200 BCE - 300 CE). As seen in the archaeological and historical evidence, the history indicates a region in constant political flux. This frontier, existing at the extremities of both the Roman and Parthian empires, created a unique sphere of potential interactions both on the individual level and

broader scale. This created a varied archaeological context played out in mortuary practices and other material artifacts at the site (Novak *et al.* 2000). In order to better understand these contexts, but also the long-term processes at the site, a multi-proxy approach was used that incorporates molecular techniques and archaeological mortuary evidence to develop an understanding of the interments from the Roman/Parthian era occupation at Tall Šeh Hamad, Syria. Ancient mitochondrial DNA profiles were created of forty individuals and analyzed to ascertain how they statistically correlated with mortuary archaeological information. Through this analysis it became apparent that the individuals of Tall Šeh Hamad were not buried based upon matrilineal relationships. However, genetic distance measured between different burial types potentially indicates a socio-economic distinction between classes at Tall Šeh Hamad that may have impacted marriage practices.

#### Missing data imputation methods and their performance with biodistance analyses

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Given the paucity of specimens available, it is necessary to extract as much information as possible for each specimen, even when only partial remains are present due to taphonomic or other destructive processes. While different methods function differently, the goal of missing data imputation methods is to accurately estimate the missing values using the other observed values. We selected four data imputation techniques: Hot Deck, Iterative robust model (IRMI), K nearest-neighbor (kNN=5) and the variable means, to examine which of the imputation methods performed best. A subset of Howells' craniometric database was used. The full sample consisted of 352 individuals from four population groups (Ainu = 86; Arikara = 69; Dogon = 99; Zalavar = 98). Twenty variables were selected to represent the entire cranium and facial skeleton. Two versions of the dataset were then created wherein values were randomly deleted from each variable so that 25% and 50% of the data were considered missing. The same data subsets were used for each of the imputation techniques, and the efficacy of each technique was based on the smallest difference between the imputed measures and actual measures. Correct classification rates and Mahalanobis D<sup>2</sup> values were calculated for the original dataset with actual measures and each of the imputed datasets in order to examine the effects of imputed data on biodistance and classification. Results suggest that kNN imputation is the most accurate method. Additionally, it was found that midface variables are more accurately imputed as opposed to cranial variables.

#### Home range shifts and demographic changes in two sympatric lemur species (*Indri* and *Propithecus diadema*) in Betampona Nature Reserve, Madagascar

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Several advantages exist for primates who remain in the same home range over time. These advantages include access to known resources and increased foraging efficiency through the development of established travel routes. We examined the demographic changes and shifts in home range location of 5 groups of habituated indri (*Indri indri*) and 2 groups of habituated diademed sifakas (*Propithecus diadema*) in Betampona Nature Reserve (BNR), Madagascar. Group demographic data and all-occurrences of feeding were recorded for each group in 2008, 2009 and 2013-14. All feeding locations were marked with a GPS waypoint. In addition to keystone sleeping and movement substrates, we used these waypoints to quantify home range location and overlap over time. The results suggest that sifaka and indri groups in BNR are ecologically and socially flexible. Both the group size and composition fluctuated over time, as did the home range size and habitat inclusion. Overall, diademed sifaka home ranges were larger than that of indri. We found that groups with demographic changes in the form of the addition or subtraction of adult individuals experienced greater fluctuations in the location of their home range than groups with stable adult membership. In several cases a shift was made to an entirely new area without the incorporation of the previous home range. Indri and sifaka behavioral plasticity observed in BNR allows these species to continue to co-exist in this small forest fragment.

#### Selection to outsmart the germs: The evolution of disease recognition and kin selection

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Human social complexity, including our ability to diagnose and treat disease, is unparalleled in the animal kingdom. The evolution of such care hinges on the cognitive ability to recognize disease in conspecifics, which is poorly understood. If disease recognition evolved in a species with the ability to recognize kin, it may have facilitated the evolution of providing care to kin. Such care for kin may have then produced selection for increased cognitive abilities, thus enabling increasingly accurate disease recognition. We test this by creating an agent-

based model in which agents' abilities to recognize disease are functions of their intelligences. Agents then apply the rule of inclusive fitness when deciding whether to provide care to diseased conspecifics. Survivors reproduce, creating offspring with intelligence values similar to those of their parents. We illustrate that the evolution of increased intelligence emerges when individuals recognize disease in kin and provide effective care. When we varied ease of transmission and probability of an infection being fatal, we found that only diseases which persisted in the population selected for increased intelligence. This suggests that selective pressures to recognize disease can produce selection for increased intelligence, potentially contributing to selection for greater social complexity.

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### Reassessing the Oldowan-Acheulean transition from a functional perspective

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The Oldowan-Acheulean transition is often argued to represent one of the most important technological transformations during the course of human evolution. Here, we examined the Oldowan-Acheulean transition experimentally and statistically, comparing the functional efficiencies of basic flake cutting tools and handaxes when undertaking a series of distinct cutting tasks with specific, known, and measurable material qualities. We compared the functional capabilities of replica handaxes both to small flake tools and also to flake tools that were statistically of equal size and mass to the handaxes. Our experimental results show that the material context in which these tools are used is crucial to their relative performance efficiencies, with basic flake cutting tools being significantly more efficient than handaxes when undertaking relatively small, precise cutting tasks. Conversely, our results also demonstrate that handaxes are significantly more efficient than basic flake cutting tools when cutting relatively large, resistant portions of material. We conclude the adoption of handaxes may have been linked to a fundamental shift in the functional field required of stone tools and that hominins were likely engaging in far more substantial cutting behaviours during the Acheulean relative to the Oldowan. We also note, however, that the comparative functional efficiencies of handaxes and flakes of equal size are far less pronounced, with a number of tasks displaying no statistical differences. Subsequently, our analyses also stress the importance of a number of other hypothesized advantages of handaxes, which may have been important in promoting their

widespread production and use during the Pleistocene.

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### Genetics, geocoding, and electronic health records: Health inequalities and genomewide association studies of metabolic and gastrointestinal diseases

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Despite controversy over the role of a race as a determinant of disease, it remains a key aspect of biomedical and health disparities research. The increased adoption of electronic health records (EHR) and wider availability of genomic data presents new opportunities and challenges in framing the role of race in health. One such challenge involves reconciling race data from disparate sources. We compared the accuracy, availability, and limitations associated with determination of race from census geocoding, EHRs, and self-reported race and compared it with biogeographic ancestry as measured from a panel of genomewide genetic markers. Across the three proxies, percent agreement compared to genetic ancestry data for identification of race ranged from 56 to 98% for "black" or "African" and from 82 to 99% for "whites" or "Europeans". Descriptive demographics inferred by geography most consistently identified "whites" but performed poorly with regard to "blacks." EHR data demonstrated strong agreement with self-report race, but suffered considerably from missing values.

Another challenge is incorporating this electronically-mined race data into genotype-phenotype association studies in both meaningful and interpretable ways. Environmental variables (e.g. food deserts; socio-economic status, etc.) correlated with both race and geography in an urban setting, and of import to metabolic diseases such as type 2 diabetes, and gastrointestinal diseases such as diverticulitis, diverticulosis, and colon polyps, can be gleaned from geographic census data. We will discuss both positive and negative impacts of incorporating such geocoded health inequality information into genomewide association studies for these diseases.

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### Twerking, Limericks, and 3D Printing: Shaking up Human Osteology Assignments

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The upper-level course Human Osteology is a requirement for undergraduates in the archaeology and biological anthropology B.A. tracks at the University of West Florida. UWF is a regional comprehensive university in Pensacola, FL, with large contingents of first-generation college students, active-duty military, and nontraditionally-aged students. This unique set of characteristics inspired us to devise a wide range of lab and in-class activities to engage a student body with diverse backgrounds and learning styles. In this presentation, we discuss three types of assignments that we have devised: 1) in-class review activities like OsteOlympics, a series of short activities that allow students to test their knowledge and win small prizes; 2) lab exercises, like asking students to describe, using anatomical terminology, the process of twerking; and 3) the utility of 3D printing, as our skeletal collection lacks hyoids and examples of pathological bone. We have also begun to assess the usefulness of the activities in fulfilling our student learning objectives; in Spring 2014, we simply gathered student feedback on the projects, but in Fall 2014 and Spring 2015, we will be more thoroughly assessing the success of the assignments, with a view to sharing the exercises online at the end of the academic year. As a lab-based science course, Human Osteology is often taught in a very structured manner, but we aim to show that within that structure is a lot of room for twerking.

### Skeletal pathology in individually documented wild Virunga mountain gorillas

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Analysis of skeletal pathology provides insight into morbidity and mortality in human as well as wild nonhuman primate populations, revealing underlying conditions that can go undiagnosed in life. There are few human skeletal samples to use as controls in osteological pathology research and even fewer confirmed non-human primate pathological examples. This study investigates the pathological conditions in the skeletal remains of 32 identified wild Virunga mountain gorillas (age: 0.14 - estimated 43 yrs; adults: 6M, 12F; immatures: 8M, 6F) from Rwanda's Volcanoes National Park with *in vivo* behavioral, veterinary, and necropsy records. Our aims are to: evaluate the incidence of skeletal pathology in this sample; and compare the manifestation of skeletal disease processes in this population with previously published studies of gorillas and chimpanzees. Rates of arthropathy (68%) and trauma (72%) were consistent with previous studies, but locations differed in comparison with chimpanzees, with fewer instances of TMJ arthropathy (41%), more instances of vertebral pathology (69%), and more fractures in the feet (41%). Most long bone fractures were in a stage of healing at time of death and occurred more commonly in males (36%) than females (11%). This study, among the first to merge extensive data collected during life with a descriptive analysis of pathology observed in the skeletons of non-human primates, provides insight for the conservation of this endangered population and increases understanding of the relationship between social behavior, life history, and health outcomes.

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#### **Findings from renewed excavations at Azokh Cave: a Middle Pleistocene to Holocene site in the southern Caucasus**

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The pattern of migration out of Africa and into Eurasia remains one of the most important considerations in the evolution of humans. Questions remain about the timing of this flux, the geographic routes taken and recent paleogenomic findings have greatly complicated this picture. Azokh Cave is located in the southern Caucasus on one of the possible migratory routes from Africa into Eurasia, and is strategically placed geographically to address some of these issues. It contains a long sedimentary succession dating to at least Middle Pleistocene times and excavations to date have shown occupation by at least three different species of hominin.

Excavations by a previous team in the main entrance passage to the cave system produced a rich faunal assemblage, Acheulian and Mousterian lithic artifacts, and hominin remains ascribable to *Homo heidelbergensis*. A new phase of systematic excavation was initiated at the site in 2002, which has produced further faunal remains, pre-Mousterian and Mousterian artifacts, and identified two additional entrance passages containing undisturbed sediments.

Significantly, the renewed phase of excavation at Azokh Cave has, for the first time, produced Upper Pleistocene hominin remains from the site. This find, a maxillary left first permanent molar tooth, was recovered from deposits dated c. 100 ka in the rear of the main entrance passage. The morphology, metrics and taurodontism present in this specimen are characteristic of Neandertal upper first molars. Crown dimensions and root robusticity are comparable to mean values for Neandertal upper first molars from the similarly dated site of Krapina, Croatia.

#### **Morphological Aspects of Friction Grasp and Body Size in Strepsirrhines**

AMANDA K. KINGSTON. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

Soft tissues are thought to play a substantial role in primate friction-grasping. The volar skin and fat pads behave mechanically as a viscoelastic tissue able to deform with applied force and return to its original shape absent stimulus. This affects the force required to break frictional bonds between the volar surfaces and substrates such that it is no longer linearly related to the mass of the object and coefficient of friction, but instead to the applied surface area and deformability of the skin and pads. This study tests the hypothesis that aspects of the volar surfaces are optimized for friction grasping through examination of morphological variations

amongst closely related strepsirrhine species with differing friction-grasping repertoires.

The cheiridia of 60 preserved strepsirrhine individuals were molded and digitized using computed tomography. From these reconstructions, the surface area and projected (flat) surface area of the volar pads were computed and compared. Additionally, skin samples were collected from thenar and hypothenar pads of 20 individuals of corresponding species for microscopic examination of the dermatoglyphic ridges.

Analysis indicates that the volar pads are adapted for friction grasping at varying body sizes: smaller species possess pads that are more protuberant per projected surface area and allow greater deformation to enhance friction, while larger species whose body mass alone is likely to fully deform these pads instead maximize surface area during grip with broader, flatter pads. The dermatoglyphic ridges also indicate adaptation for friction grasping by body size, with narrower ridges present in smaller-bodied species.

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#### **Agent-based modeling of hominin evolution-environment interaction**

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Current hypotheses linking hominin evolution in Africa to environmental change remain difficult to test, primarily due to a lack of resolution and scaling mismatches between relevant data sets. There is an acute need to develop new perspectives as well as data on the links between global and basinal scale environmental change, and to relate these to ecological factors that may have influenced hominin evolution. Ongoing research by the Hominin Site Paleolake Drilling Project (HSPDP) is providing a high-resolution environmental framework through the analysis of long drill cores retrieved from hominin-bearing successions in Kenya and Ethiopia. As part of this investigation, we are using Agent-Based Modeling (NetLogo) to explore interactions between evolution and environmental change and investigate how simple rules might shape emergent properties of these complex systems in space and time. Through simulations of multiple autonomous agents interacting dynamically with each other and their environment, the model simulates alternate scenarios of environmental change and variable responses of hominins and their communities to these changes. Specifically we are evaluating developmental plasticity, micro- or macroevolutionary change, behavioral flexibility, and/or habitat tracking as strategies to navigate environmental change. Varying



configurations of the model suggest that evolutionary systems are highly sensitive to discrete parameters of environmental perturbations, such as the timing/speed of change, geographic extent of change, environmental heterogeneity, and magnitude of change. The ultimate goal of these models is to develop more specific hypotheses that will help direct the focus of research and utilize available empirical fossil and environmental data to test them.

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#### Dental trauma and primate sociality

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In addition to elucidating morbidity and mortality, sex differences in trauma patterns potentially correlate with mating and social strategies. Sexual dimorphism in adult canines and their use as weapons suggest that patterns of breakage in this tooth type may be especially informative for assessing sex differences in trauma patterns. I compare rates of canine breakage across 4 primate taxa (*Gorilla gorilla* (n=128), *Hylobates* sp. (n=32), *Pan troglodytes* (n=195), and *Papio cynocephalus/anubis* (n=33)), and test whether taxa with greater sexual dimorphism (and presumed levels of male-male competition) have higher rates of and larger sex differences in canine breakage. Results largely support the hypothesis. Gorilla and baboon males have the highest rate of canine breakage (26%). Sex differences in breakage rate are significant for gorillas ( $z=-3.56$ ,  $P=0.0002$ ), but cannot be demonstrated for baboons due to small sample. Interpretations of canine breakage in gibbons (22%) are ambiguous due to restricted sample size. Chimpanzees of both sexes have the next highest rates of canine breakage (20%); rate does not differ for males versus females ( $z=0.20$ ,  $p=0.58$ ). It is possible that male baboons (26%) exhibit higher breakage rates than females (7%). This finding would be of particular interest if further supported with a larger sample because both baboon sexes sustain fewer skeletal injuries than chimpanzees, but greater levels of sexual dimorphism in baboons might otherwise predict higher trauma incidence in male baboons. Considering dental injuries may therefore provide more complete information on sex differences in trauma patterns and their possible correlations with sociality.

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#### Now and then: Linking public health research to bioarchaeological methodology

CASEY L. KIRKPATRICK. Anthropology, Western University.

Dental age estimation is central to most forensic and bioarchaeological studies of subadult human remains. A sound knowledge of the timing and sequence of dental development is also useful in the fields of dentistry and orthodontics, certain sociocultural studies, and legal or immigration investigations of living subadults with missing, or suspect, birth data (El-Nofely and Iscan 1989; Liversidge 2008; Maber et al. 2006). Through meta-analysis, it is apparent that the existing dental age estimation standards are the most accurate and specific aging standards based on macroscopic features of subadult human remains. However, some of the methods and reference samples used for the creation of these standards may have contributed to bias within the resulting age estimation standards.

This poster presents a new method for the creation of region-specific subadult dental age estimation standards. This method involves data collection from 1020 voluntary participants, within a month of their birthdates, through expanded World Health Organization (WHO) questionnaires, and free dental examinations and panoramic radiographs. Bayesian statistical equations reduce population distribution bias (Hoppa and Vaupel 2002) in this standard, increasing accuracy and specificity in age estimates for modern and ancient populations. The social benefits of this method include the production of a public oral health report and the contribution of data to the WHO's global oral health database. This project demonstrates the ability to advance bioarchaeological methods through the use of qualitative and quantitative data, while simultaneously contributing to the improvement of quality of life in modern populations.

#### The evolution of the human niche: assessing and describing the development of complex decision-making in the Pleistocene through an open-access, comparative database

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It is clear that there are some behaviors unique to humans, such as the creation of complex lithic artifacts. Unaddressed for the most part, however, has been how behaviors such as collaboration, landscape use and alteration, symbolic thinking, aesthetic preference, ritual behavior, and stigmergy (self-organization) are expressions of the pattern of multifaceted decision-making that early humans undertook when creating and navigating complex social networks. Here we investigate the role this networking played in the origin and development of the cultural human experience. To examine

this we developed a framework to evaluate Pleistocene human communities via the pattern (both biotic and abiotic) their behavioral processes leave in the paleoanthropological record. Here we report on the development of a large-scale, open-access comparative database of paleoanthropological sites, which includes behavioral patterns, materials used, types of representation/item produced, possible uses for these items, and, where available, local ecological and demographic parameters. These data are being assessed to develop a model to better understand material patterns that can provide insight into the creation and use of a distinctive human niche(s) and indicate how these experiences shaped other evolutionary processes. Specifically, through the use of this database we demonstrate that specific changes occurred in the material record between 500-100 kya that engendered substantial changes in the human behavior. Examining these data under the umbrella of niche construction theory allows a framework to bridge between the biological, archaeological, and cultural sciences

#### GenBank and the promise of online resources for undergraduate research

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Undergraduate involvement in research is increasingly seen as a net positive for students, research faculty, and colleges and universities. Students gain valuable experience and knowledge prior to starting a research career, faculty advance their research, and universities employ these opportunities to recruit talented undergraduates to their campuses. However, the brevity of undergraduate research programs typically precludes the completion of ambitious projects, especially those involving large datasets and complex analysis. Here, we describe how publicly available genetic data, free online programming courses, open-source population genetic software, and cloud-based super-computing resources have reduced the temporal restriction on the scope of undergraduate research as performed by undergraduates at the University of Iowa. We identify several key areas in which online resources enhanced the analytical component of undergraduate research. First, publicly available online data allows mentors and undergraduates to focus on the development of analytical expertise, which is often precluded by the necessity of time-consuming data collection. Second, open-source population genetic software and web-based high performance computing resources allow undergraduate students to analyze data using state-of-the-art methods run on powerful computers, which are often unavailable in sufficient quantity locally. Finally, free online computer programming courses enable students to gain expertise in scripting languages, data manipulation, and algorithmic thinking that supplements hands-on instruction by mentors.

We conclude that in combination these features enable more undergraduates to perform more expansive research with faculty, and that these same features allow the extension of meaningful research experiences outside of the university and into a high school setting.

**Hybrid howler monkeys discriminate phenotypes based on acoustic features but not temporal patterns of loud calls**

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Secondary contact between closely-related species offers the opportunity to explore how individuals recognize conspecifics. Using playback experiments, we previously found that hybrid howler monkeys (*Alouatta palliata* x *Alouatta pigra*) in southern Mexico had stronger responses to vocalizations from males whose phenotypes (based on morphology and behavior) matched their own. However, because *A. palliata* and *A. pigra* calls differ in both acoustic (e.g., fundamental frequency) and temporal features (e.g., call length), it remained unclear how listeners distinguished callers. To investigate how discrimination was achieved, we modified loud calls from six purebred males (three of each species, recorded at allopatric locations) to temporally match the phenotypically opposite callers, while retaining original acoustic parameters. Then, to twelve hybrid groups (six of each phenotype, hereafter *pigra*-like and *palliata*-like), we broadcast one call sequence of each type (temporally *pigra*-like/acoustically *palliata*-like or temporally *palliata*-like/acoustically *pigra*-like) on different days. In ten of twelve groups, the strongest responses (look, move and vocal behaviors) were elicited by calls that acoustically matched the listeners' own phenotype but temporally matched the opposite phenotype (Wilcoxon signed ranks,  $p = 0.041$ ). Thus, howlers attend to acoustic features but appear to ignore temporal pattern variation. Our previous data suggests that acoustic features may be the most reliable indicators of species membership; in naturally produced hybrid calls, we found that acoustic features tended to resemble caller phenotype, whereas temporal patterns were intermediate. If acoustic features are relatively inflexible across species, they may be widely used for species recognition.

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**Race, Genetic Ancestry, Biomedical Research, and the Politics of Trust**

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Genetics continues to be integrated into medicine to build personalized or individualized medicine plans. Thus, understanding how genetic variation is structured within and between populations is important for the future of medicine. Personalized medicine utilizes genetic information in clinical practice and has improved diagnostics, pharmacogenetics, development of new drugs, risk assessment and ultimately risk modification. Although there is promise in personalized medicine, it is still an expensive concept and, historically, studies mainly have focused on individuals of European ancestry. The health status of communities of color varies across the country and is linked to the socio-political histories of those communities. The history of racism, marginalization and segregation in the U.S. vary and impact health outcomes. It is clear that genetic differences exist between human populations. These genetic differences are loosely correlated with socially defined race, which is largely based on skin color. Here we show the biological ambiguity of socially classified *race* using U.S. data. We also explore genetic ancestry in the Americas and discuss how skin color has racial meaning and how skin color and genetic ancestry can be used to understand health disparities.

**Can sexual dimorphism be expressed differently across human populations?**

AMANDA G. KITTOE. Department of Anthropology, University of Kansas.

This study asks whether or not sexual dimorphism can be expressed differently across human populations, particular among European-American (EA) and African-American (AA) skulls. Morphology of the skull is a classically referenced indicator of sex; and, variation of size and shape has been found to differ significantly between ancestral populations. Any information concerning variation in the expression of sexual dimorphism between ancestral populations would aid osteologists in estimating sex in individuals of both known and unknown ancestry. This study is divided into two phases. Phase I consists of a sample of 55 AA females, 50 AA males, 49 EA females and 49 EA males with mixed representation from the Hamann-Todd Collection at the Cleveland Museum of Natural History and the WM Bass Donated Collection at the University of Tennessee, Knoxville. Multivariate analysis of nineteen linear measurements suggests that sexual dimorphism is expressed differently between AA and EA in four of these measurements (i.e.

cranial length, cranial height, cranial base length and mandibular angle). Phase 2 consists of a sample of 53 AA females, 48 AA males, 53 EA females and 57 EA males all from the Hamann-Todd Collection. In this case, multivariate analysis of four cranial measurements (i.e. cranial length, cranial width, cranial height and cranial base length) suggests that there is no difference in sexual dimorphism between AA and EA. These paired findings offer insight into variation within and between defined populations as well as the effect of secular change on cranial morphology.

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**Reconstructing the impact of infectious diseases on the immune system of human populations: periodontal disease as marker to detect immunological shifts?**

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The immunological competence of an individual is a reflection of its evolutionary history and different infectious diseases play a significant role constantly re-shaping the immune response. While the immune system plays a fundamental role in protecting us from pathogens, many of its mechanisms are also major contributors to tissue damage and disease. The strong association between the expression of different pro-inflammatory proteins and periodontal tissue destruction could allow us to use periodontal disease in skeletal remains as a marker for the inflammatory status of individuals or populations. The objective of this study is to develop experimental *in vitro* protocols that will improve our understanding of how exposure to one pathogen species (*Yersinia pestis*, or *Mycobacterium leprae*, or *Mycobacterium tuberculosis*) can generate a shift in the expression of immune proteins (TNF- $\alpha$ , IFN $\gamma$ , and IL-10) produced by human peripheral blood mononuclear cells subsequently affecting the immune response to oral pathogen *Porphyromonas gingivalis*. Preliminary analysis showed that TNF- $\alpha$  is altered when cells are exposed to *Y. pestis*, *M. leprae*, or *M. tuberculosis* and subsequently affecting the immune response when those same cells are exposed to *P. gingivalis*. While TNF- $\alpha$  enhances the cellular response against oral pathogens, it could also induce excessive osteoclastogenesis and bone destruction; therefore the immunological shift generated by co-infections should be taken into consideration when analyzing periodontal disease in skeletal remains. We propose that periodontal disease could be

used as a proxy for inflammatory status or competence when reconstructing the health profile in past populations.

#### **Craniometric variation in Ancient Egypt and influences from the East**

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Egypt's central location between Europe, the Middle East, and Africa likely contributed to its genetic diversity. Numerous studies have analyzed population variation of Ancient Egyptians to establish their origins. Debate about its affinity has historically focused on ancestry and the effects of migration into Egypt from the Nubian corridor, Red Sea littoral, and the eastern Mediterranean. While these regions surely contributed to Egypt's diversity, few studies have examined how this manifested in a particular location. What might the "local data" indicate about the broader implications of diverse morphometric expression?

For this research, 16 cranial measurements were collected from 3D computed tomography models of 25 Egyptian mummies, most of which originated from Akhmim and primarily date to the Ptolemaic Period. Individuals were classified using discriminant function analysis and cluster analysis into the Howells' Craniometric Data Bank. These results were then situated within our current understanding of Egyptian population affinity.

The results suggest a high degree of heterogeneity. Seven individuals classified as Egyptian, while three classified into another African group and nine classified into Asian groups. Using cluster analysis, most individuals grouped within Howells' Egyptians with the exception of one. The proximity of the Arabian Peninsula to Egypt and the narrowness of the Red Sea likely facilitated the migration of populations from Eastern and Western Asia into Egypt. The high percentage of individuals (36%) that classified into an Asian group rather than the Egyptian, African, or European samples may also suggest a greater influx of groups from the East than previously considered.

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#### **The Timing of Childhood Metabolic Stress: Initial Perspectives from Incremental**

#### **Microstructures of Tooth Enamel in Lambayeque, Peru**

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The study of metabolic stress is key to reconstructing the biocultural consequences of European conquest on Native Americans. Past research in Peru has identified unexpected divergences between elevated skeletal markers and lowered linear enamel hypoplasia (LEH) prevalence in the postcontact period. To further explore this phenomenon, this pilot study tracked age-at-defect formation in a small sample (N = 9) of Muchik individuals from pre- and postcontact settings in Lambayeque, Peru using incremental microstructures of enamel. Perikymata were observed in high-resolution casts using an engineer's measuring microscope outfitted with digital encoders. LEH were identified based on the presence of accentuated perikymata (2.0 or more standard deviations from neighboring perikymata). Cuspal formation times were based on histological studies of Native Americans and perikymata periodicity follows modal periodicities reported in the same samples (8 days). Age-at-defect formation was estimated by multiplying the number of perikymata from cuspal tip to the affected microstructure by 8.0, adding this value to the appropriate cuspal formation time (in days), then dividing this factor by 365. Here, median age-at-defect formation was 2.2 years (mean = 2.0 years; mode 1.7-2.3 years). The interquartile range for age-at-defect formation in the sample was 1.6 -2.8 years. These results may suggest LEH was attributed to stressors associated with weaning. Also, age of defect formation between pre- and postcontact individuals did not differ. Thus, the roots of other macroscopic skeletal stress markers may not be directly tethered to differing ages of exposure to childhood metabolic stress.

#### **Mitochondrial D-LOOP variation and structure of two island populations of urban macaques (*Macaca fascicularis*)**

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The islands of Singapore and Bali, Indonesia both host healthy populations of long-tailed

macaques (*Macaca fascicularis*) living at the urban interface. Singapore is Bali's inverse in many ways including a smaller overall macaque population of 1,400-2,000 compared to 12-30,000 on Bali. Singapore clumps forest amongst a primarily urban background opposite Bali's landscape of concentrated human habitation within forest and agricultural fields. In Singapore provisioning macaques is illegal and human food comes primarily from illicit feeding by humans and garbage raiding by monkeys, whereas in Bali, populations are heavily provisioned around temples, with dense urban build-up nearby. This study utilized mitochondrial D-LOOP Hypervariable Region I (HVI) to examine how the differing anthropogenic contexts of these two islands impacts levels of genetic variation and patterns of mtDNA genetic structure. Haplotype networks, maximum likelihood and Bayesian phylogenetic trees were generated and Bayesian analysis of population structure, AMOVAs, tests for isolation by distance were also run. Standard diversity indices and FST values were calculated as well. Results indicate genetic differentiation is strongest between sites within Bali, whereas for populations in Singapore most variation occurs within groups. Similarly, a strong relationship exists supporting isolation by distance for the Bali macaque populations, whereas, isolation by distance does not explain genetic differentiation within the Singapore populations, regardless of whether only HVI or both HVI and HVII are used. Overall, Singapore has lower genetic variation across all standard diversity indices, which should be considered when planning future management actions for the population.

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#### **Prenatal exposure to sex hormones in relation to sex hormones in women of reproductive age**

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**Objectives:** Second-to-fourth digit ratio (2D:4D) is proposed as a proxy for prenatal balance of sex hormones and is related to hormone-dependent characteristics in adult life. It has also been suggested that 2D:4D is related to sex hormone concentration during adulthood,



and thus that it is a marker of relationship between prenatal and postnatal circulating sex hormone levels. Here, we studied the relationship between 2D:4D and ovarian steroid hormones (17 $\beta$ -estradiol and progesterone) among women of reproductive age.

**Methods:** 186 healthy, premenopausal women, aged 24–37 collected daily saliva samples during the entire menstrual cycle. Data on reproductive and lifestyle characteristics were collected via questionnaires and anthropometric measurements were performed.

**Results:** No statistically significant relationships were detected between adult women's sex hormone concentrations (17 $\beta$ -estradiol and progesterone) during the menstrual cycle and 2D:4D, in either left or right hand, when controlling for factors that may influence levels of hormones (e.g. size at birth, BMI and physical activity).

**Conclusions:** This study shows, for the first time in a large sample of reproductive age women, that 2D:4D is not a predictor of adult women's sex hormone concentration. The lack of relationships may be due to the fact that 2D:4D is not related to maternal nutritional environment during fetal development. These results support the hypothesis that, in contrast to a quality of nutritional fetal environment, fetal hormonal environment (reflected by 2D:4D) does not determine women's reproductive physiology in later life.

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#### **Craniomandibular integration in anthropoid primates with implications for mandibular symphyseal fusion**

RYAN P. KNIGGE. Department of Anthropology, University of Minnesota.

Mandibular symphyseal fusion in anthropoids has been characterized as a unique morphological state in comparison to other primates with varying degrees of symphyseal fusion as a consequence of different underlying mechanisms. Previous work suggests that increased encephalization, basicranial flexion, and facial kyphosis in anthropoids elicit a higher temporomandibular joint and changes in the orientation of the masseter muscle that ultimately lead to symphyseal fusion. Fusion is also associated with more robust dimensions of the corpus and symphysis in the mandible. Some researchers have hypothesized that these craniomandibular features constitute an integrated evolutionarily stable configuration. However, the integrative relationships among

these various cranial and mandibular components have not explicitly been tested. The preliminary analysis presented here tests this hypothesis using 3D geometric morphometrics. For a diverse sample of platyrrhines and catarrhines, skull shape was captured using a series of landmarks and semi-landmarks from which the cranium and mandible were superimposed by a generalized Procrustes analysis. A singular warps analysis identified shape patterns that covary between the cranium and mandible in the anthropoid sample. Although variation within the cranium follows the predicted pattern of correlated shape change (increased encephalization, basicranial flexion, and facial kyphosis), the hypothesized mandibular shape was not found. Rather, these cranial shapes are associated with shorter mandibular condyles and corpus height but a wider mandibular arch. These initial results do not support the assumption that these features constitute an integrated configuration and highlight the need for a better understanding of anthropoid craniomandibular integration in relation to mandibular symphyseal fusion.

#### **Infant carrying in orangutans: Implications for human evolution**

CHERYL KNOTT. Anthropology, Boston University.

Hominin infants are hypothesized to have become increasingly altricial during human evolution. Thus, understanding how maternal behavior is affected, and potentially constrained, by the needs of an increasingly dependent offspring is important for reconstructing changes in hominin social structure and when mothers would have needed assistance in caring for such offspring. I address this question by examining data from 2760 focal follows of orangutan mothers, 531 follows of juveniles age 5-8, and 408 follows of infants age 0-4 to determine the relationship between the offspring's age and developmental competence and their position on the mother's body. Data were collected over a 20 year period on orangutans from Gunung Palung National Park, Borneo, Indonesia. Infants spent 97.6% of their daytime hours in the same tree as their mothers and 2.4% of their time in a different tree. In juveniles this changed to 62.5% of their time in the same tree and 37.5% in a different tree. Infants spent 20% of their time on the mother's body as opposed to only 1.5% of the time in juveniles. When traveling between trees, mothers with clinging infants spent 10.2% of their time brachiating and 89.8% of their time in quadrumanous climbing. During feeding bouts mothers spent 82.5% of their time sitting and 12.3% of their time hanging from both feet and 1 hand. The most common infant position was on the mother's side during all activities, including arboreal travel. Infant clinging behaviors were also examined. Implications of these findings for human evolution are discussed.

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#### **Oral Health Inequality and the Erie County Poorhouse (1851-1913) in Light of the American Dental Revolution**

KEVIN C. KNOWLES and JOYCE E. SIRIANNI. Department of Anthropology, University at Buffalo.

The Erie County Poorhouse, established in Buffalo, New York in response to growing poverty, was located at what is now the University at Buffalo's South Campus. In 2012, skeletal remains were recovered from the Erie County Poorhouse Cemetery (1851-1913). Archaeological analysis of artifacts and coffin alignment suggest a temporal boundary between the older and more recent sections of the cemetery. This time period marked a revolution for dental medicine in the United States. The first dental school opened in Baltimore (1840), the American Dental Association was founded in Niagara Falls, NY (1859), and dental restorations improved in quality and affordability (i.e. vulcanite dentures). This research analyzes oral health within this sample through time in light of these advances in dentistry.

Data from 253 individuals were scored for dental pathologies, restorations, and oral health scores—calculated using a modified version of dentistry's Oral Health Index—to assess dental health. Gini coefficients were calculated to determine dental inequality. These factors were compared across the two sections of the cemetery to determine changes through time.

The later section of the cemetery is marked by greater incidences of antemortem loss (87%), more dental restorations, and lower rates of calculus (28%) than the earlier section (76% antemortem loss; 36% calculus). Oral health scores did not differ significantly through time ( $p=0.375$ ). While the Gini coefficients are similar between the earlier (0.218) and later sections (0.2424), there is a trend suggesting that some individuals in the later part of the cemetery had better access to dental care.

#### **Using coalescent simulations to understand population dynamics of the admixture process**

ANTHONY J. KOEHL and JEFFREY C. LONG. Anthropology, University of New Mexico.

The purpose of our study is to investigate the accuracy of maximum likelihood estimates of genetic ancestry under different models of the admixture process. We use Fastsimcoal to



simulate two models of admixture. The first model, termed Single Admixture Event (SAE), depicts a single event of interbreeding between two isolated source populations. The second model, termed One-Way Gene Flow (OGF), depicts a constant influx of genes from one source population into an admixed group. We simulated varying levels of contributions from the parents in both models, used maximum likelihood to estimate ancestry in the simulated populations, and then compared the estimates to the known values from the simulations. We allowed for the misspecification of source populations to increase the realism of our statistical analyses. To do this, we simulated proxies for the source populations and substituted them in our analyses for the true source populations. Proxies are populations related to the source population, but did not contribute to the admixture event. We found that maximum likelihood estimation had low bias with a single admixture event and equal contributions from the true source populations. However, they were biased when in versions of the SAE wherein one source contributed more than the other to the admixed population, overestimating the minor contributor. The bias increases nearly threefold when we substituted proxies for the true source populations. One-way gene flow created biases similar to those created by single event admixture. Thus, a more complex population mixing process did not require a more sophisticated analysis.

#### **Rate of agonism may be the only useful predictor of despotic dominance hierarchies**

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The ecological model of female social relationships suggests that rates of agonism relate to characteristics of dominance hierarchies such as directional consistency, linearity, and steepness with frequent agonism associated with despotic hierarchies. In addition, diet categories have been implicated as predictors of dominance characteristics. Here, we tested these ideas with a comparative sample of nonhuman primates (16 species, 17 populations, 21 groups) derived from published sources. We extracted data on directional consistency, linearity, and steepness (dependent variables) as well as rates of agonism, percentage of fruits and leaves in the diet, substrate use, female group size, and number of unknown relationships (independent variables). We used both standard and phylogenetically controlled methods including least square and phylogenetic generalized least square regressions. We found that none of the

hierarchy characteristic were related to agonism in conventional or phylogenetic analyses ( $P > 0.1$ ). However, agonism was a (weak) positive predictor for directional consistency when cercopithecine and non-cercopithecine taxa were contrasted (phylogenetic ANCOVA,  $P < 0.1$ ) with a stronger relationship in non-cercopithecine taxa. From all the other predictors only the number of unknown relationships (indicative of insufficient data) and partially female group size were related to linearity and steepness with more unknown relationships and larger groups being associated with lower linearity and steepness. These results confirm the problematic nature of linearity and steepness data. Instead, only the rate of agonism seems to relate to directional consistency. This link only becomes apparent when larger taxonomic units are viewed separately, potentially indicating phylogenetic grade shifts in despotism.

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#### **Morphological differences in skeletal form in wild- and captive-born Primates**

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Wild- and captive-born Primate populations have been widely used in developmental, morphological, physiological and behavioral studies, providing valuable insights on Primate biology, genetics, evolution and conservation. Few studies have compared detailed morphological differences between wild- and captive-born Primates. This study tests for differences in skeletal form and developmental stability between wild- and captive-born Primates.

Postcranial dimensions of the shoulder girdle, upper limbs, pelvic girdle, lower limbs were recorded for four Primate taxa: free-ranging rhesus macaques (*Macaca mulatta*) from Cayo Santiago, captive-born rhesus macaques from Wisconsin National Primate Research Center; wild- and captive-born saddle-back tamarins (*Saguinus fuscicollis*), cotton-top tamarins (*Saguinus oedipus*), and common marmosets (*Callithrix jacchus*) originally from Oak Ridge Associated Universities Marmoset Research Facility. Differences in dimensions between wild- and captive-born animals were estimated by analysis of variance, and differences in developmental stability were estimated by analyses of fluctuating asymmetry.

Significant differences between wild- and captive-born macaques, tamarins and marmosets were observed, with wild-born primates significantly larger than captive-born primates.

Captive-born primates exhibited significantly greater fluctuating asymmetry, especially for scapula and innominate dimensions.

While the macaque samples represent different genetic populations, the tamarin and marmoset species represent one breeding colony per taxon. In each case, the wild- and captive-born colonies also experience environmental differences including diet and habitat. Environmental differences, including restricted locomotor patterns, are evident in postcranial form. Differences between wild- and captive-born individuals should be adjusted for before prior to inclusion of both groups in research studies.

#### **Reexamining postmarital residence in prehistoric West-Central Illinois**

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In his dissertation and a later paper, Konigsberg (1987, 1988) used the archaeological within-site distribution of cranial discrete traits in males and females to infer postmarital residence patterns for prehistoric West-Central Illinois. Twenty years later, Bolnick and Smith (2007) used mtDNA haplotypes in males and females from one of the sites and found results that contradicted those from Konigsberg. In this presentation we return to the original cranial discrete data and reanalyze it using newer methods that have grown out of studying DNA sequence diversity. To motivate the study, we first reanalyze Bolnick and Smith's data by finding the mean number of pairwise DNA base differences within males and within females, and then bootstrap DNA across 351 base-pairs. We find more variation within males than within females, as did Bolnick and Smith, but the 95% bootstrap confidence limit for the ratio of male to female mean pairwise differences does include a ratio of 1.0. As a result of small sample size, it is difficult to detect all but the largest deviations from a ratio of 1:1. Turning to the cranial discrete data, we only have 23 phenotypic traits versus the 351 bases, but the sample size is much larger. Using the within-site ratios of male to female mean pairwise differences in discrete traits, we find clearly higher levels of variation in females for the eleven pre-Mississippian sites, and clearly higher variation in males for the three Mississippian sites. This suggests a shift from virilocal to uxorial residence over time.

#### **Adaptation of cancellous bone to habitual loading: Trabecular architecture of the artiodactyl calcaneus**

DERINNA V. KOPP. Antiquities Section, State of Utah, Department of Anthropology, University of Utah.

The functional adaptation model suggests that habitual loading will be reflected in trabecular architecture and trabecular architecture is increasingly used to examine habitual loading/locomotor history in extant and extinct species in anthropology. However, most research is limited since it is not currently known exactly how trabecular architecture differs with varying principal loading conditions. The artiodactyl calcaneus has been shown to be habitually loaded in bending and an appropriate model for assessing functional adaptation. This study used the artiodactyl calcaneus to assess trabecular architecture variation with respect to compression and tension. MicroCT scans and 3D architectural analyses were used to assess differences in trabecular architecture under compression and tension. While some statically significant differences in trabecular architecture were identified, much of the variation in the trabecular architecture across the length of the bone and between the compression and tension regions was not statistically significant suggesting that loading regime alone may not be sufficient to explain trabecular architectural variation. In the artiodactyl calcaneus cortical bone plays a significant role in bearing loads and trabecular architecture appears to be correlated with cortical bone thickness and distribution more than with load type. The use of trabecular architecture to identify or distinguish habitual loading/locomotor activity for extant and extinct species may be premature. Additional work is needed to identify skeletal elements with known loading mode and magnitude that can then elucidate the relationship between loading mode/magnitude and trabecular architecture bone before it can be applied to unknowns as a diagnostic tool.

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#### **Craniofacial pneumatization scales isometrically in extant Strepsirhini**

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Scaling properties of craniofacial pneumatization have been investigated for most anthropoids, but evaluation across the order Primates has been limited by the lack of quantitative information on Strepsirhini and Tarsiidae. This information is essential, however, given that aspects of sinus presence/size has been used in phylogenetic analyses across many subdivisions of the order.

To address this, crania of most of the genera of extant lemurs, lorises and tarsiers were examined by peripheral quantitative computed tomography (pQCT) imaging. Sinus volume was obtained by

segmentation of CT scans using SurfDriver. All extant strepsirhine genera possess a maxillary sinus, and most have a sphenoidal (cupular) sinus, as well. A small number of Malagasy taxa have a frontal sinus, but without the corresponding ethmoidal pneumatization seen in hominines. The volume of the maxillary sinus in the group is closely correlated with facial volume and the relationship is not significantly different from isometry, mirroring the relationship seen in hominoids.

Phylogenetic optimizations suggest that maxillary and sphenoidal sinuses are primitive for both Strepsirhini and Primates and that multiple independent origins of all of the paranasal sinuses are seen in the order. Analysis of maxillary sinus volume against facial volume across the order Primates reveals that strepsirhines, hominoids, some platyrrhines and macaques living in warm climates share a common, isometric regression relationship; other taxa (some platyrrhines, macaques from high latitudes) display deviations that may help to elucidate some of the factors affecting mammalian craniofacial pneumatization.

#### **Group sex ratio and group size alter stress and behavior of male *Pan paniscus***

ANNA C. KORDEK and LEILA M. PORTER. Department of Anthropology, Northern Illinois University.

In *Pan paniscus* (bonobos), social groups are characterized by female dominance and a female-biased sex ratio, social features that are likely to influence the behavior of males. In this project I examined agonistic behaviors and cooperative behaviors of male bonobos at the Columbus Zoo to determine if sex ratio and group size influence their stress levels, and the frequency of agonism and sociosexual behaviors. In total I collected 250 hours of observation on 6 different males from June - August, 2013. All males belonged to one social group, but they formed different subgroups in different enclosures on a daily basis. I used a General Linear Mixed Model to test for correlations between subgroup composition and stress-related behaviors. The results show that there is a positive correlation between group size and scratching behaviors ( $F=4.82$ , Num DF= 2, Den DF= 44,  $p=0.01$ ). In addition, males in groups which had more females than males exhibited more frequent sexual behaviors ( $F=4.59$ , Num DF= 1, Den DF= 45,  $p=0.04$ ). The results show that males are more stressed in large groups and that males use sexual behaviors to reduce stress in groups in which the sex ratio is biased towards females. This study suggests that males adjust their behavior in order to cope with their subordinate status in their social group.

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#### **Social variation of menarcheal age between 1966 and 2012 in Polish girls**

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Menarche seems to be very sensitive to environmental factors, especially to socio-economic status of family and level of economic development of country. For the last 48 years Poland underwent remarkable socio-economic transition from centrally planned to free market economy. The aim of the study was to assess the changes in social variation of age at menarche (AM) in Polish girls between 1966 and 2012.

Four cross-sectional surveys were conducted in 1966, 1978, 1988 and 2012 in Poland, where 36 753 girls aged 7-18 were investigated. Average AM was based on status quo method and assessed by probit analysis. The rapid acceleration occurred between 1966 and 1978 where AM changed from 13.79 to 13.09, then decelerated to 13.26 in 1988, and again accelerated to 12.97 in 2012. This pattern was repeated in changes of AM in each level of considered social factors. The highest decrease in AM was observed in rural girls and changed from 14.11 to 13.11 between 1966 and 2012. The economic changes during this period were the most advantageous for the girls with elementary educated father, where their AM significantly departed from other educated groups, accounted for 13.45, whereas in 2012 those differences diminished, accounted for 12.99. Similar pattern was observed in girls with elementary educated mother.

The AM revealed to be a very sensitive biological indicator of socio-economic conditions. Observed changes in social variation of AM indicated that in free market economy the stratification power of analyzed social factors lost its significance, especially visible in the urbanization level.

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#### **Proximal tibial shaft proportions in extant hominoids and early hominins**

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The proximal tibial shaft reflects important functional differences in the knee joint of humans compared to other hominoids. The proximal tibia of modern humans is expanded,

with proximo-distally wider epicondyles, compared to that of apes. In particular, the shaft lateral to the tibial tuberosity is expanded in humans and excavated in apes. The human pattern is related to weight transfer through the hind limbs during bipedal walking. Consequently, the expansion of the tibial plateau has been used as evidence to infer bipedalism in early hominins. However, this trait has not previously been quantified. We investigated tibial expansion in apes and humans using tibial shaft transverse cross-sectional area in order to compare these to the condition in fossil hominins. Transverse cross-sectional area of the proximal tibia was measured at 2mm intervals using three-dimensional scanned surfaces of human, chimpanzee, gorilla, orangutan, and gibbon tibiae, as well as Plio-Pleistocene hominin fossils. Additionally, the tibiae were sagittally sectioned in order to compare medial and lateral expansion. Results confirm that proximal tibia cross-sectional area decreases proximo-distally more rapidly in apes than it does in humans. This pattern is more pronounced in the lateral than the medial section of the tibia. Hominin proximal tibiae have a human-like pattern which appears to remain unchanged from the Pliocene onwards.

#### Determinants of reproductive success in Batek hunter-gatherers in Peninsular Malaysia

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Reproductive success is the fundamental currency of evolution and reflects the contribution of social, behavioral, physiological, and ecological factors. In humans, a correlation between reproductive success and hunting ability has been demonstrated in several hunting and gathering populations, but alternative predictors of reproductive success such as social metrics or non-hunting foraging success have not been examined. In addition, the long lifespan of humans makes it difficult to measure lifetime reproductive success and previous studies have instead focused on the determinants of age-corrected reproductive success. In this study we used a historical economic dataset from the 1970's in combination with long-term genealogical data to examine the determinants of lifetime reproductive success in Batek hunter-gatherers in Peninsular Malaysia. We examined the alternative hypotheses that hunting success, gathering success, and/or social attributes derived from cooperative foraging networks predict reproductive success. We present an information-theoretic analysis to test these alternative hypotheses and discuss the implications of investigating lifetime reproductive success rather than age-corrected

reproductive success. Our results demonstrate the potential for using quantitative attributes from social network analysis to address outstanding questions in human behavioral ecology and attest to the critical advantages of collecting longitudinal data in hunter-gatherer studies.

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#### How evolutionary changes in human life histories affect juvenile energetics

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Human life histories have evolved in ways that significantly affect the energy and time parents allocate to rearing offspring. The energetic lives of juveniles also have changed substantially during hominin evolution. Juveniles in the past were likely self-sufficient at a young age and the direction of selection has been toward a longer period of dependence. Because modern juveniles are subsidized, it is often assumed that they increase the energetic burden on mothers, which in the past either limited surviving fertility or selected for adult cooperation. These assumptions in part stem from the analytic approaches used to quantify the cost of children. Most analyses have focused on food returns, measures of parental net investment, and analogies from ethnographic populations. From this perspective, juveniles appear expensive and a constraint on maternal investment budgets. In this paper, I reevaluate assumptions about juvenile dependence by constructing a model that: 1) uses energy-adjusted time budgets as a more sensitive measure of costs and investments; 2) accounts for the effects of overlapping offspring; 3) varies juvenile dependence to simulate the evolutionary transition from a juvenile who is self-provisioning at a fairly young age to one who is dependent until older ages. When the cost of children is simulated through evolutionary changes in birth intervals, dispersal ages and juvenile dependence, model results show that under a range of early life history changes, juveniles pay for themselves. Only under more derived life history conditions do overlapping offspring present a constraint for mothers and pressure to recruit adult cooperation.

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#### New algorithm to determine heel strike and toe-off in walking when force detection is not available

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The kinematic parameters of walking can often reveal important characteristics of an animal's interaction with their environment. Parameters such as heel strike (HS) and toe-off (TO) are particularly important, because they describe the period of contact with the substrate. Visual inspection of motion data is a benchmark method for determining these parameters, but it is laborious. Automatic algorithms, which typically rely on assessment of landmark velocity, require little input to implement, but have proven unreliable. Our goal was to create a Matlab algorithm that replicated the process that researchers use when they visually assign HS and TO, but that can be automated.

We collected the kinematic data on three groups of people using an eight-camera Qualisys motion capture system with a Kistler force plate. Participants walked at self-selected slow, normal, and fast velocities (30 trials). We used marker data to predict HS and TO and compared these predicted values to the HS and TO values assessed using a force plate. The groups include: 20 shod and unshod women, used to develop the algorithms (DEV); 16 women and 10 men who walked in their normal walking shoes, used as the first validation group (VAL1); and 8 women who walked unshod, used as the second validation group (VAL2).

Our algorithm predicted HS and TO reliably: all  $r^2 > 0.95$  and all  $p < 0.001$ . Our results are, at this time, limited to humans with normal gait walking on level surfaces, but offer the opportunity to expand this approach to other situations.

#### Implications of occlusal contacts in Caenopithecids (Adapiforms) and extant Lemuriforms

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Comparisons between extant strepsirrhines and adapoid primates have led to similarities found between the two. For example *Afradapis longicristatus*, a folivorous adapoid from the Fayum Depression in Egypt (Eocene, ~37mya), shares a large, well developed hypocone and large mesostyle with the extant folivorous primate *Propithecus* (Indriidae). Previous work using orientation patch count (OPC) and relief index (RI) have identified species of *Propithecus* as possible extant analogues for studying the diet and dental morphology of *Afradapis*. Expanding upon the functional dental morphology in *Afradapis* must address occlusal patterns, hypothesized here to resemble *Caenopithecus lemuroides*, its closest relative. Among extant folivorous strepsirrhines, *Propithecus* is hypothesized to be most similar to *Afradapis*. An analysis of upper and lower second molars from both fossil (*Caenopithecus*, *Afradapis*) and



extant (*Hapalemur*, *Lepilemur*, *Propithecus*) primates was conducted. Teeth were MicroCT scanned and loaded into Occlusal Fingerprint Analysis (OFA) software. Teeth were manipulated into approximate occlusion, and an occlusal pathway following Phases I and II of mastication was constructed. Contacts between upper and lower teeth along this pathway were analyzed, providing total and average occlusal area for each molar from each species. Standardizing the data permitted analysis and observation independent of size. Total occlusal area of contact groups *Propithecus* with *Caenopithecus*, excluding *Afradapis*, yet average instantaneous area of contact clusters all three taxa together. The data do not support the hypothesis, instead providing support for *Propithecus* as an extant analogue for *Caenopithecus*. This is likely reflecting a similarity in diet between *Propithecus* and *Caenopithecus*.

#### Fluvial Transport of Human Remains in the Three Rivers of Allegheny County, PA

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Over the years, studies of fluvial transport of human remains have been conducted on a variety of different rivers. This study uses the fluvial model from Bassett et al. (2002) and applies it to the Allegheny, Monongahela, and Ohio Rivers in Allegheny County, Pennsylvania. The aim is to create a database of river victims, analyze time and distance human remains travel as well as any relationship between these factors, and also to create a model of fluvial transport for the three rivers of Allegheny County that can be used for future investigations.

A total of 147 cases were collected for all aqueous deaths in the county. Variables were separated into two categories; demographic data and river dynamics. Of the 147 original cases, 80 cases were complete for the demographic data and river determination of where the remains were found. Of these 80, only 26 had complete data sets for the temperature and preservation aspect of this study.

Analysis shows that most victims are between 20 and 49 years, comprising 37.5% of the 80 victims. The younger age ranges suffer from more accidents, which decrease with age. Suicides increase with the age. A Chi-square analysis was performed in SPSS for sex and manner of death, age range related to manner of death, and condition of preservation and length of time in river. No significant differences were discovered. No further analysis could be made for transportation as there was no data available for any of the 80 viable cases for this study.

#### A preliminary analysis of dental metrics from elite Mycenaean tombs at Sykia and Kalamaki, Greece

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The emergence of the Mycenaean civilization during Late Bronze Age Greece marks the beginning of one of the earliest socially stratified societies in the prehistoric Aegean and a time characterized by widespread cultural change. The Mycenaean elite exercised sociopolitical and economic control over other classes and it is thought that membership was restricted based on kin group. Previous research, focusing mainly on material culture and the interpretation of Linear B texts, has assumed homogeneity in Mycenaean social organization and in the composition of the elite class throughout the Greek mainland. However, osteological data, particularly biodistance studies, have not been widely considered in these interpretations until recently. This purpose of this study is to investigate biological structuring within and between elite chamber tombs from two Mycenaean sites on the Greek mainland, Sykia (NW Peloponnese) and Kalamaki (Laconia) using dental metrics as an indicator of underlying genetic variation. Preliminary results demonstrate biological similarity among those buried within tombs at both sites, suggesting that both elite status and interment into these tombs was restricted based on kin affiliation. Additionally, analyses between sites support the results of previous research in that membership in the Mycenaean elite class was restricted, with little gene flow from outside groups. Similarity of results for both sites suggests there was indeed a homogenized Mycenaean social structure throughout the Greek region. These findings add to recent literature demonstrating the contribution that biodistance studies can make to the understanding of past sociopolitical structures.

#### Frontal and Browridge Covariation in Modern Humans

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Although the shape and volume of the browridge are among the most widely discussed features when examining variation across sexes, hominin species, and modern human populations, the development, function, and physical constraints affecting the morphology of this facial structure remain poorly understood. One competing hypothesis suggests that the browridge evolved as a structural bridge between the neurocranium and viscerocranium and develops in response to ontogenetic changes in both regions. This study analyzes the relationship between browridge and frontal morphologies to evaluate whether they

display covariation patterns supporting this 'structural hypothesis.' Landmarks and semilandmarks defining the browridge and overall frontal morphologies were collected from surface scans of 162 modern crania of both sexes of European-American, African-American and Nubian descent. Following Procrustes superimposition, M/ANOVA tests, PLS regression and Spearman's rank correlation analyses were run on PC scores and Procrustes landmarks in order to assess frontal and browridge variation and covariation. Although sex and ancestry differences exist in both frontal and browridge morphologies ( $p < 0.001$ ), PLS results indicate that the relationship between the two structures is weak at best (highest RV coefficient = 0.181). Additionally, Spearman's rank correlations performed between individual PC's suggest that the browridge and the frontal bone, as depicted by the landmarks in this study, do not present any highly correlated shape components. Overall, these results do not support the structural hypothesis of browridge function and variation.

#### Dental maturity score in chimpanzees

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A dental maturity score (DMS) summarizes the overall status of permanent tooth development, and can be used in regression with a known-age reference sample to predict age. DMS is the sum of individual tooth developmental scores; for the Demirjian tooth mineralization system, DMS ranges from 0-64 (8 stages for 8 permanent teeth). While age estimation requires some understanding DMS variation with age, it is not known how DMS varies with respect to developmental stage of individual tooth types or with overall patterns of crown and root mineralization. For a given DMS score, how much do individual tooth stages vary for each permanent tooth? How many, and which teeth actively contribute to DMS score at earlier and later developmental periods?

A radiographic data set derived from 118 previously studied known-age chimpanzees was used to calculate the DMS from the left permanent mandibular dentition. Using cross-tabulations and nonparametric statistics, this study assesses variation in DMS in relation to individual tooth development scores and in different subsets of tooth types, such as molars.

Results of this analysis indicate that: a) age variation increases with higher DMS values; b) the developmental status of tooth types varies by 2-5 stages for a given DMS value; and c) crown formation of all teeth is complete for DMS scores between 40-48, and only root formation contributes to further increases in DMS.

This analysis provides a comparative framework for modern humans, apes, and fossil primates;



the utility of DMS for assessing life history variation remains untested.

**The high metabolic costs of human brain development help explain the unusually slow body growth of human childhood**

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The high energetic costs of human brain development have been hypothesized to explain unique features of the human life history, including slow and protracted pre-adult growth. Although widely assumed to constrain life history evolution, the metabolic requirements of the growing human brain are unknown. We used previously collected PET and MRI data to calculate the human brain's glucose use from birth to adulthood, which we compare to the rate of body weight growth. We evaluate trade-offs between brain metabolism and body growth using the ratios of brain glucose uptake to the body's resting metabolic rate (RMR) and daily energy requirements (DER) expressed in glucose-gram equivalents. The ratios of brain glucose-to-RMR or -DER do not peak at birth, when relative brain size is largest, but in childhood, when synaptic densities related to learning are maximal. At 4 years, the brain uses twice the glucose of the adult brain, accounting for the equivalent of 66% of RMR. Consistent with the hypothesis of a brain-body growth trade-off, body weight growth velocity is strongly inversely related to brain glucose demands from infancy until puberty, and maximal brain glucose demand co-occurs with slowest body weight gain. Our quantification of the metabolic costs of the developing human brain support the hypothesis of a trade-off between brain metabolic needs and body weight growth rate. They thus provide rare empirical support for the hypothesis that the slow and protracted growth that characterizes human childhood evolved as compensation for the

unusually high glucose requirements of human brain development.

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**You are what you eat: Further analysis of the diet and feeding ecology of Barbary macaques (*Macaca sylvanus*) in Gibraltar**

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Diet is often considered one of the driving forces of primate behavior, mating systems, and social structure. Although primate diet and feeding ecology has been studied extensively in forest populations, less is known about the complex diet and feeding patterns of human-sympatric primate groups, particularly those that live in and around urban areas. Increased access to human food resources as a result of urbanization has been demonstrated to influence wildlife group sizes, social structure, behavior, breeding, diet and ecology. Isotopic analysis of hair and fecal not only provide information about diet, but can also serve as a proxy measure for intensity of human interaction.

We examined the diet and feeding ecology of Barbary macaques (*M. sylvanus*) using stable isotopes analysis of hair and fecal samples collected from within at least six distinct social groups within the Upper Rock Nature Reserve, Gibraltar, and compared the behavioral patterns and activity budgets of two focal groups. The four groups with the greatest contact with and access to human settlements had diets slightly, but significantly, enriched in <sup>13</sup>C and <sup>15</sup>N as compared to a group that was largely isolated from tourists. These isotopic differences suggest macaques interacting with tourists consume more commercially-produced agricultural products, and C4 foods, likely from human-provided foods. We also examined over 130 hours of focal behavioral sampling in order to examine the relationship between feeding patterns and activity budgets, with preliminary data analysis revealing a correlation between access to human food sources and increased social interaction and resting behavior.

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**Variation in Infant Feeding Practices in Ancient Greece: Stable Isotope Analysis of Serial Sections of Dentin**

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Serial sections of dentin collagen from adult teeth are analyzed for stable carbon and nitrogen isotopes from three ancient Greek populations from the Bronze Age (Kalamaki, 3100-1065 BC) and Byzantine periods (Nemea, Stymphalos, 5th-6th c. AD). This approach is used to investigate variation during tooth formation, which reflects infant feeding practices. The permanent first molar and first premolar are obtained from a total of 88 individuals. Each tooth is sectioned horizontally into 5 sequential parts and dentin collagen from each segment is analyzed for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Using this approach, individual isotopic profiles are established. It is also possible to assess sex differences within samples, and variation between sites. From the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values, most individuals are weaned between 2 and 3 years of age. However, infant feeding strategies are not consistent within populations. For instance, nitrogen isotope results suggest that some individuals were never breastfed while others were weaned at a later age. Moreover, a sex-based difference is present as males were weaned earlier than females. The stable carbon and nitrogen isotope results also indicate that variation existed in the type of supplementary foods consumed by individuals during weaning. Written records from the Greco-Roman period are also consulted and compared to the stable isotope evidence to comprehend how this childhood process varies in antiquity.

**Can oral pathology avoidance explain human dental size reduction?**

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Human posterior dental size reduction through the Pleistocene and early Holocene is well documented, but the cause has been debated (e.g., the probable mutation effect). Here I explore the hypothesis that oral pathology avoidance may have played a role in the observed tooth size reduction. For oral pathology avoidance to explain—at least partially—posterior dental size reduction, individuals with smaller teeth should show lower prevalence of caries, impacted third molars, alveolar lesions, and periodontal disease (alveolar resorption). Using a data set of Late Pleistocene Neandertals and early modern humans (N=253 individuals) and individuals from three Holocene hunter-

gatherer groups (N=149), a correlation between oral pathological condition status and molar dental metrics was tested. Logistic regressions were calculated for both upper and lower molars' (left and right sides pooled) individual buccolingual diameter and full molar arcade mesiodistal length to predict oral pathological condition likelihoods from tooth size. Results suggest that smaller teeth show less alveolar resorption, but are not associated with less of the other pathologies. This is likely related to larger temporal trends such as an increase in caries from dietary shifts in the Late Upper Paleolithic. Caries and impacted third molars are still rare in the Late Pleistocene sample suggesting the hypothesis should be tested in samples with higher prevalences of oral pathological conditions. Because periodontal disease was common in the Late Pleistocene, these results indicate periodontal disease avoidance could play a role in posterior dental size reduction.

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#### **Does secondary bone distribution in limb bones reflect locomotor behavior in primates?**

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Assuming different locomotor behaviors involve different mechanical loads, we hypothesize that the amount and distribution of secondary bone in primate limbs reflect behavior-specific loading regimes. We examined remodeling in the humeri and femora of four cercopithecoid taxa for which positional behavior is known. Osteon density (OD, total osteons/mm<sup>2</sup>), osteon fragment density (OFD, total fragments/mm<sup>2</sup>) and osteonal area (OA, osteonal bone area/mm<sup>2</sup>) were calculated for femoral and humeral midshaft sections from populations of *Colobus polykomos*, *Procolobus badius*, *Cercopithecus diana*, and *Cercocebus atys* derived from Taï Forest, Côte d'Ivoire. Data are analyzed for the entire section and for regions (anterior, posterior, lateral, medial) within sections. The *C. polykomos* femur has greater OD (4.25), OFD (1.21), and OA (0.09) than other species, which may relate to the frequent bounding gait practiced by this species. The posterior region in femora of all species exhibits greater values (from 50-911%) compared to other regions. The four taxa have similar OD (CV=8%) but more variable OA (CV=20%) for the humerus overall. However, the distribution of osteonal bone in the humeral midshaft is non-uniform. *Cercopithecus diana* has high values medially and low values anteriorly, in marked contrast to other taxa. This pattern is associated with unique cross-sectional geometry in the diana monkey. This preliminary investigation supports the hypothesis that secondary bone characteristics covary with locomotor mechanics. Relative uniformity of humeral values suggest that locomotor diversity

is more important than variation in activity pattern for determining osteon distribution and cross-sectional geometry.

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#### **Species recognition among Lower Pleistocene fossil hominins based on distal humeral diaphyseal shape**

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The coexistence of multiple hominin species during the Lower Pleistocene has long presented a challenge for taxonomic attribution of isolated postcrania. Although fossil humeri are well-suited for studies of hominin postcranial variation due to their relative abundance, humeral articular morphology has been of limited value for species recognition among *Paranthropus* and *Homo*. On the other hand, distal humeral diaphyseal shape has been used to justify generic distinctions at Swartkrans. The potential utility of humeral diaphyseal shape merits larger-scale quantitative analysis, particularly as it permits the inclusion of fragmentary specimens lacking articular morphology. This study analyzes shape variation of the distal humeral diaphysis among fossil hominins (c. 2-1 Ma) to test the hypothesis that specimens can be divided into distinct morphotypes.

Coordinate landmarks were placed on 3D laser scans to quantify cross-sectional shape at a standardized location of the humeral diaphysis (proximal to the olecranon fossa) for a variety of fossil hominins and extant hominoids. The fossil sample includes specimens attributed to species based on associated craniodental remains. Mantel tests were used to assess hypotheses about fossil relationships by comparing empirically-derived Procrustes distance matrices to hypothetical model matrices. Diaphyseal shape variation is consistent with the hypothesis of three distinct morphotypes (*Paranthropus*, *Homo erectus*, *H. aff. habilis*) during the observed time period. The *H. erectus* group exhibits morphology similar to that of modern humans, *Paranthropus* is more ape-like, and *H. habilis* is unique among the hominoids. Variation among groups likely reflects different patterns of force distribution through the elbow.

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#### **Chewing efficiency variation with food material properties and masticatory morphology in humans**

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A reduction in the size of the dentition and masticatory complex are among the features used to define the genus *Homo*, and are associated with dietary changes and a reduction in food material properties. *Homo* and *Australopithecus* are therefore predicted to have differences in chewing efficiency resulting from these morphological changes, particularly of tough food items. From these predictions, we hypothesize that humans with a larger dentition and masticatory complex are more efficient than smaller subjects at processing foods with greater toughness and hardness. To test this hypothesis, 30 human subjects completed chewing trials that were recorded using high speed motion capture and surface electromyography of the superficial masseter and anterior temporalis muscles. Each subject's dentition was cast and occlusal surface morphology was quantified using dental topographic analysis. Trial foods varied in toughness and hardness, and the material properties were measured using a FLS-1 portable universal tester. Overall, subjects were significantly less efficient when chewing foods of greater toughness and Young's modulus. Increased occlusal surface area was significantly positively correlated with chewing efficiency for foods of greater toughness; however, variation in occlusal surface area did not significantly predict variation in chewing efficiency for foods of lower toughness. These results suggest that the decrease in dental and masticatory size in *Homo* was coupled with a decrease in chewing efficiency of tough foods. We discuss the implications of these results for dietary strategies in *Australopithecus* and for interpreting diet material properties from dental and masticatory morphology.

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#### **Life on the Santa Barbara Channel Islands, ca. 9,500 B.P.: Insights from the Dentition of Tuqan Man**

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The dentition of Tuqan Man, an adult male who lived on San Miguel Island, California

approximately 9,500 years ago, provides an important window into the childhood stresses and subsistence adaptations of coastal Paleoamericans. This complete dentition shows no signs of dental caries, but exhibits moderate-to-severe dental wear, ubiquitous chipping, several antemortem tooth fractures, slight-to-moderate dental plaque, and enamel hypoplasia. Compensatory eruption associated with severe wear of the maxillary first molars has also led to root exposure and abscessing at these tooth sites, findings confirmed by CT scans (UTCT) of the upper jaw. While the dental data suggest that cariogenic plant foods such as the starchy roots and tubers of geophytes--plant foods important to later Channel Islanders--may not have been a significant component of the diet for the earliest inhabitants, the corms of blue dicks have been identified in early island archaeological deposits and would certainly have been an important source of dietary grit. Other grit laden foods such as shellfish, seaweed and foods processed or cooked in a sandy environment are also suggested by the dental data. These and other observations provide a basis for reconstructing the diet and health of this early islander, and serve to broaden our understanding of the subsistence adaptations of Paleoamericans more generally.

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#### **Testing a behavioral cumulative-risk model for dysentery on a historical population: Outcomes and modern applications**

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Bacillary dysentery, caused by the bacteria *Shigella dysenteriae*, remains a major health concern in modern refugee camps and other similarly enclosed, circumscribed living arrangements. However, the ability of medical anthropologists and other health personnel to address the risk factors associated with morbidity and mortality can be limited by logistic, funding, and safety concerns. A modeling approach capable of capturing variation in human behavior provides one avenue to address these concerns.

Using the agent-based modeling program NetLogo, we developed a cumulative risk model to examine the incidence and distribution of bacillary dysentery in a confined population. Agent-based models can be particularly appropriate tools to address these sorts of questions, as they are capable of incorporating individual choice and agency to lend realistic variety and chance to the model environment. The resulting model is capable of capturing the impact of environmental (e.g., contamination of food, soil, water) and behavioral (e.g., latrine habits, social activities) risk factors on an

individual's risk of both contracting and transmitting *Shigella*.

The model was then tested by recreating the spread of dysentery in two Civil War prison camps, which serve as a historical, well-documented proxy population. The camps also allowed us to test the model on two unique living/social arrangements, improving its robusticity and ultimate applicability to modern camp-living environments. The model outcomes, tested on the Civil War camp populations, revealed that asymptomatic carriers may play a larger role in the spread of dysentery than has previously been recognized, and that general environmental contamination a lesser one.

#### **Dietary trajectories and stable isotope analyses indicate marked diversity between neighboring sites of Samtavro and Tchkantiskhed (Republic of Georgia, 1<sup>st</sup> – 6<sup>th</sup> c. AD)**

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Carbon and nitrogen stable isotopes extracted from a permanent first molar, femur and rib chart an individual's lifetime dietary trajectory, and provide evidence for changing subsistence patterns and/or migration. We conducted isotope analyses using bone collagen of 24 individuals from Samtavro and Tchkantiskedi in the Greater Mtskheta region of the Republic of Georgia. These contemporaneous sites dated between 1<sup>st</sup> – 6<sup>th</sup> c. AD are situated 15km from each other. Samtavro was renowned in Soviet times for providing rich skeletal evidence of the changing cultural landscape during the early Christian and Migration periods, including varying burial patterns and cranial modification. The importance of this material is only just being realized through up-to-date scientific analyses.

We sampled individuals from stone-cist, tiled-cist and sarcophagus burials, with and without modified crania. We included adults of both sexes and juveniles. Eleven individuals were included in the dietary trajectory study. Both parametric and non-parametric tests were used to study significance of differences.

The overall isotope results indicate a predominantly C3-based terrestrial diet, with some evidence of C4 plant consumption. There was no evidence for dietary differences between burial-types, age, sex or cranial modification. Both carbon and nitrogen stable isotope results differed significantly between Samtavro and Tchkantiskhed and demonstrate greater diversity in dietary practices between these neighboring sites than had been documented previously. Two individuals showed evidence of non-local diet.

This study provides a clearer picture of diet and migration during a significant historical period. Future studies will use augmented sample sizes to strengthen these emerging results.

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#### **Tuberculosis in the American Museum of Natural History Medical Skeletal Collection: Comparing an Osteological Dataset to Historical Records**

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Discrimination and marginalization of individuals based on factors such as socioeconomic status, race, and gender have the potential to influence health. This is evident in the epidemiology of tuberculosis, a social disease that disproportionately infects individuals of low socioeconomic status and racially oppressed minorities. It is important to know how accurately skeletal samples reflect past rates of tuberculosis in order to root the disease in history and to better understand its current state and future trajectory.

In this study, 132 individuals from the American Museum of Natural History's (AMNH) Medical Skeletal Collection were examined for signs of tuberculosis in the form of lesions on the vertebrae, joints, ribs, and skull. The collection was acquired from New York City area medical schools between 1945 and 1950 and includes individuals of known age, sex, and race. Only two "white" males showed strong evidence of the disease. Possible cases of tuberculosis in the collection were then compared to historical rates of the disease in the New York City area. While the overall rate of tuberculosis in the sample did not differ significantly from the historical data, a comparison by race showed higher rates in white individuals than blacks, which is not consistent with the historical record.

This outcome is most likely the result of many factors, including the formation of the AMNH Medical Skeleton Collection itself, issues of differential diagnosis, and the osteological paradox. These results reflect the challenges and limitations of using skeletal samples in historical epidemiology studies.

#### **Does Progression Velocity Predict Heel Strike and Toe-Off?**

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Describing the gait cycle, including parameters like heel strike (HS) and toe-off (TO), is key to understanding the kinematic patterns of moving primates, because kinematics can often reveal important characteristics of an animal's interaction with the environment. For instance, contact time, the time in contact with the substrate, has been correlated with the energy expenditure of locomotion. A laboratory setting with automatically detected markers and multiple force plates that unequivocally establish when contact occurs is ideal, but not always feasible. Evaluating locomotion in natural environments rarely can rely on force plates, so HS and TO is predicted from some criteria, such as the velocity of particular landmarks. In humans, instantaneous velocity of the heel and the metatarsal-phalangeal joints are frequently used.

To establish the efficacy of the instantaneous velocity criteria, we collected the kinematic data of 20 females using an eight-camera Qualisys motion capture system with a Kistler force plate. Participants walked shod and unshod (30 trials each) at self-selected slow, medium, and fast velocities. We used marker data to predict HS and TO and compared these predicted values to the HS and TO values assessed using the force plate. We found that the prediction is strongly influenced by the progression velocity ( $p < 0.001$ ,  $r^2=0.84$ ). In light of these findings, we are developing a more complex algorithm to identify reliably HS and TO in the absence of a force plate.

#### **Femoro-acetabular impingement in a skeletal assemblage from medieval Nubia**

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Femoro-acetabular impingement (FAI) is a pathology of the hip resulting in restricted motion at the superior contact point between the femoral neck and the acetabulum. FAI is the result of developmental differences in the shape of the femoral head and neck, leading to extra bone formation depending on activities and weight bearing through the joint. FAI describes three classes of lesions: cam lesions on the femoral neck, pincer lesions on the acetabulum, and combined impingement, which is the presence of both cam and pincer lesions. FAI is common among high-level athletes in cutting and pivoting sports and has been studied extensively in the clinical literature. However, it has received little attention in the paleopathology literature. Here, we present a new method for scoring the presence and severity of impingement lesions in mature individuals from skeletal assemblages. We examined the presence and severity of impingement lesions in two cemeteries from the medieval site of Kulubnarti, Nubia, in which previous studies have shown high levels of nutritional stress and trauma. Results show the presence of both cam and pincer lesions as well as combined impingement in the population,

ranging in severity from mild to severe. FAI has a high rate of co-occurrence with knee arthritis and eburnation, suggesting the two may occur as a result of similar activities such as grain grinding, which would increase loading through the knees and the superior and posterior aspects of the acetabulum. Thus, FAI may be useful for studying activity patterns in the archaeological record.

#### **Signals related to the advent of walking reflected in the growth allometry of long bone cross-sectional dimensions for a sample of Central Californian Amerindian children**

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We investigated how long bone cross-sectional dimensions (CSDs), i.e., area moments ( $I$ ) and section moduli ( $Z$ ), reflect the change in mechanical loading associated with the onset of walking in an archaeological sample. Reduced major axis regression residuals informed about over- or underestimation of CSDs by diaphyseal length. ANCOVAs tested for homogeneity of slopes across age groups. Ratios provided measures of relative rigidity and growth velocities. Bootstrap estimated regression slopes informed about scaling of CSDs to length across age groups (0 to 60 months [mos]). CSDs signaled distinct periods of postural changes. Such morphological data can be used to investigate further the factors affecting subadult long bone growth.

CSDs of upper limb (UL) bones increased faster than lower limb (LL) bones in the first year, presumably related to crawling. Relatively high CSD growth rates at 6-9mos and 18-24mos potentially reflect body weight shift to the LL and a response to more habitual bipedalism, respectively. High rates in the latter age interval were maintained during the 24-36mos period despite slowed length growth potentially due to weaning stress. LL length growth always outpaced CSD growth, potentially to allow for adult limb proportions. In older children, CSD growth increased in the LL bones, presumably to counteract the increasing bending strain. Similar patterns in the non-weight-bearing fibula perhaps signal the increased use of plantarflexors and evertors as gait matures. AP and ML CSDs did not differ in growth, supporting past studies showing that bone is not necessarily reinforced in the axis of maximum strain.

#### **A Wrinkle in Time: Allostatic Load and Senescent Decline among Elderly Japanese**

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Senescent decline varies substantially within and among populations. To extend knowledge on modern human variation at older ages, we assessed allostatic load (AL) as a measure of senescent decline among 123 residents (aged 55-88) from Nagasaki Prefecture. Examining AL in an older Japanese sample, we contribute to understanding senescence, human biology, and physiological dysfunction across populations. Additionally, Japan boasts high life expectancy, is relatively genetically homogenous, and has a steadily increasing elder population.

AL provides a summary measure of physiological activity and dysfunction across multiple neurosomatic regulatory systems. It is calculated by summing across assessed biomarkers, each scored as 1 when an individual's value is in the highest risk quartile and 0 otherwise. We use the ten standard biomarkers to determine AL, but calculate it using raw and standardized data. Bivariate and multivariate regressions were used to determine significant associations between AL and ## biomarkers of physiological function, controlling for age, sex, and age by sex interactions.

AL is higher among men, but not clearly associated with age. Based on raw data, AL associates significantly with GTP and GPT, biomarkers of liver function, and white blood cell count, an indicator of immune system activity. Based on standardized biomarkers, AL associates significantly with white blood cell count and the neurotransmitter dopamine. Associations remain significant when controlling for age, sex, and age by sex interactions, but did not with raw data, suggesting AL calculated from standardized data improves reliability. We interpret results as suggesting AL is cross-culturally valid for assessing physiological dysregulation.

#### **Bony facial buttressing in South African australopiths: a finite element analysis**

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Australopiths exhibit a number of derived facial features that are thought to “buttress” the face against high and/or repetitive loads associated with a diet that included mechanically challenging foods. These purported facial buttresses, which vary in their expression among australopiths, are hypothesized to confer structural strength to the facial skeleton during biting. However, the geometrical complexity of the face makes these hypotheses difficult to test. Here, we examine the biomechanical significance of the zygomatic root (ZR) and the anterior pillar using previously constructed finite element models (FEMs) of MH1 (*Australopithecus sediba*) and Sts 5 (*A. africanus*). We warped the shape of the MH1 ZR to that of Sts 5, and vice versa. We also assessed ZR positioning by posteriorly and anteriorly shifting the ZRs of the unwarped FEMs. Lastly, we compared Sts 5 to “pillarless” variants of that specimen.

Results show that a straight/steep ZR reduces strains across many facial regions for both MH1 and Sts 5. Similarly, the unmodified Sts 5 was stronger than “pillarless” variants. However, MH1 and Sts 5 variants with anteriorly placed ZRs experienced higher strain magnitudes than those with posteriorly placed ZRs. Thus, an anteriorly positioned ZR weakens the face. We infer that an anteriorly placed ZR evolved to enhance the efficiency of bite force production while other buttressing features that strengthen the face may have evolved in part to compensate for the weakening effect of this facial configuration.

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### Similarities in the primate vertebral formulae and implications for phylogeny and locomotor behavior

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Vertebral formulae have largely been overlooked in terms of primate phylogenetics in favor of craniodental traits. Variation in the primate vertebral formula as defined by the number of vertebrae in each region (i.e. cervical, thoracic, lumbar, and sacral) effectively lengthens or shortens the vertebral column. Consequently, vertebral count greatly affects a critical point of support in the primate skeleton which, due to its importance, may provide data that will inform primate phylogenetics.

In order to address this gap, we have assessed vertebral formulae for twenty two primate taxa in order to construct a neighbor-joining tree using vertebral counts of 3,033 individuals derived from Williams (2012). Included in the assessment are nine hominoid, nine Old World monkey, and four New World monkey taxa. Using Pilbeam’s (2004) normalized morphological similarity index we investigated a ratio of shared vertebral patterns to the total variation represented by two populations.

Our results indicate the vertebral formulae for primates group in three main clusters: Old World monkeys with squirrel monkeys on one end, great apes, humans, and the siamang on the other, and capuchins, howler monkeys, spider monkeys, and white-handed gibbons in between. Within hominoids, gorillas, bonobos, and chimpanzees form a cluster distinct from humans, orangutans, and siamangs. Knuckle walkers share more similarity in their vertebral numbers than the primates with alternative locomotor behaviors (e.g. bipedal and suspensory locomotor behavior). As a result, it is likely that variation in primate vertebral formulae reflects phylogenetic relationships broadly, but also correlates with patterns of locomotor behavior.

### Ancient DNA analysis of human remains from the Siberian Arctic

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Archaeological evidence illustrates the presence of human occupation in the Arctic Siberia by 27,000 years before present (YBP) but the population history of these early inhabitants is not fully understood. Genetic research on contemporary indigenous Siberian populations has suggested a distinct pattern between populations from south/central Siberia and the extreme northeast Siberia. However, the picture is complicated by the fluctuations of movement by various culture groups in the last millennium that has resulted in admixture as well as genetic drift. In order to better understand the genetic history of early humans in northern Siberia, we obtained ten human skeletal remains from four areas of the Siberian Arctic: Low Indighirka River, Low Kolyma River, Yana RHS site, and the Zhokhov site. We extracted DNA from the skeletal remains ranging from around 27,000 YBP to as recent as the 18<sup>th</sup> century AD and analyzed the mitochondrial DNA control region. We successfully identified maternal lineages for five individuals that include haplogroups A2 and C4. More frequent in south/central Siberia, the presence of haplogroup C4 in northern Siberia as early as 8,000 YBP illustrates the antiquity and widespread presence of the maternal lineage in the region. On the other hand, the presence of haplogroup A2 is consistent with its presence among contemporary northeastern Siberian populations. Overall, the results from our ancient DNA analysis provide valuable insights into the genetic history of Arctic Siberians.

### Physical activity levels in women of reproductive age in rural Poland

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Habitual physical activity (PA) is associated with skeletal, cardiovascular, and reproductive health benefits in women of reproductive age, but data is lacking on the variation present in worldwide populations. This pilot study investigated PA levels in 8 women (age 28.5(2.4) years, weight 61.3(5.6) kg, body fat 23.4(3.2)%, mean(SE)), at the Mogielica Human Ecology Field Site in rural, agricultural Poland using standard surveys every day for one full menstrual cycle and commercially available PA trackers (FitBit One) for one week. The PA tracker data was collected from day 6 day through day 12 after the luteinizing hormone spike signaling ovulation to control for possible variation in PA over the menstrual cycle. This PA data was analyzed for

the duration, frequency, and intensity of PA bouts as well as to calculate the duration and frequency of sedentary behavior. We hypothesize that this population of women are likely to perform more low-to-moderate-intensity PA as part of their daily lives than women of similar age in more industrialized locales. Preliminary results (mean (SE)) show that Polish women travel 8904(1307) steps per day, much more than rural US women who walk on average 4000-6300 steps/day. Time spent being lightly active, moderately active, and very active were measured as 247(28), 92(16), and 15(3.9) minutes, respectively. This research is an important component in looking at differential health outcomes resulting from variation in habitual PA, such as prevalence of osteoporosis and risk of cardiovascular disease which may vary in diverse populations.

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#### Modern DNA analysis of the Mijikenda

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The Bantu-speaking Mijikenda currently live in southeastern Kenya, but collectively claim Singwaya, an area probably located in southern Somalia, as their ancestral homeland. However, some historians have argued that European colonial rule led the nine tribes now known as the Mijikenda to unite as a result of economic and political pressure. Even in light of researchers contesting the veracity of Mijikenda's ethnicity the Mijikenda collectively claim their shared origin from Singwaya is supported by their shared cultural practices, kaya social structure and shared language—their three dialects are mutually intelligible—among the nine tribes.

The mtDNA hypervariable region I (HVRI) sequences of an expanded sample of 334 individuals from all nine tribes were analyzed. Genetic analyses were carried out based on linguistics, shared cultural traits, the geographical location of each tribe and the Singwaya origin myth. Exact tests, AMOVA and genetic distance analyses were performed and a multidimensional scaling (MDS) plot was generated to better visual the genetic distances. The sample represents a variety of haplogroups of which the most prevalent were L0a, L3e, and

L3bd suggesting the Mijikenda have retained haplotypes of Central and Western African origin.

Based on the genetic analysis among the Mijikenda they appear to be genetically similar, but genetically differentiated between tribes. The results support historians who believe that the Mijikenda identity represents a relatively new ethnic identity forged by British Colonial policies instead of shared origins. Preliminary Y-chromosome analyses are in progress that will permit comparison of gendered gene flow patterns.

#### Taurodontism in Review: Methods of determination and anthropological utility

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Taurodontism, the expansion of the pulp chamber of a tooth, has been a well-known feature of both fossil and modern humans since the early 20<sup>th</sup> century. In modern populations taurodontism is clinically important, as any increase in pulp chamber size affects the endodontic treatment options, but its archaeological importance among anatomically modern human groups remains unclear. It is often seen as a defining characteristic of the post-canine dentition in Neanderthals and is sometimes used as an indicator of phylogenetic affinity for European fossils. Since the 1960s a number of studies have examined the frequency of taurodontism in modern human populations; however, the results vary wildly. The data are not always comparable, as some studies use premolars and molars whereas others use only molars. Further, some of the studies only report the frequencies by individuals rather than the sample as a whole. The common element among all methodologies to date is the usage of radiographs to measure crown and pulp chamber sizes. A potential drawback to this mode of data collection is using a 2-dimensional image to make a judgment about a 3-dimensional space. This study reviews the various methods for determining the presence of taurodontism in modern populations, including five different formulae used to describe the condition biometrically, and suggests a new methodology to standardize measurements, taking a volumetric approach through high-resolution x-ray micro-computed tomography (micro-CT).

#### Determinants of primate sex ratios: an analysis of demography in Verreaux's sifaka (*Propithecus verreauxi*)

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Sexual selection predicts that males strive to monopolize paternity by residing with few reproductive competitors, while females benefit from the presence of many males. Primate groups are often disproportionately comprised of females. However, lemurs deviate from this norm with even or male-biased sex ratios. We used demographic data from five groups of Verreaux's sifaka (*Propithecus verreauxi*) in the Kirindy Mitea National Park from 2007-2014 to (1) describe variation in group size and composition, (2) examine proximate determinants of sex ratio, and (3) explore the hypothesis that unusual sex ratios in lemurs are ultimately driven by infanticide risk. Mean group size was 6.2 individuals (range: 4.9-7.4) and 80% of groups were unexpectedly female-biased. Neither birth rates nor survival to subadulthood differed between the sexes, but males dispersed at higher rates than females and rarely delayed natal dispersal. Contrary to expectations, infant disappearances were not significantly associated with entrances by extra-group males. Thus male-biased migration had a greater proximate effect on adult sex ratio than sex differences in birth or survival in this population. Our results are consistent with low overall infanticide risk, which may influence sex ratio by lessening constraints on female group size and reducing the benefit of surplus males for takeover defense. Sifaka have been suggested to live in neighborhoods with flexible mating boundaries, so entrances by neighboring males may pose little threat because adjacent groups might contain their offspring. Interestingly, while infant disappearances associated with entrances occurred very infrequently, most involved an immigrant from outside the study population.

#### Accounting for nutrient composition in human foraging decisions

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We report on the caloric content and macronutrient composition of foraged foods in the Twe diet. The Twe are an understudied population of forager-horticulturalists in Northwest Namibia who regularly collect a range of plant foods. We combine observational foraging data with data on energy expenditure and nutritional analysis to understand the motivations underpinning Twe foraging decisions. Consistent with traditional behavioral ecology models, we find that calorie-based diet rankings explain many Twe foraging decisions. However, recent government programs provide an abundance of carbohydrate rich maize meal, and we expect that Twe foraging is biased towards foods that improve their dietary macronutrient balance.

Lessons drawn from hunter-gatherer diets feature in popular hypotheses about the evolution of human diets and health. Many foraging models assume that calorie acquisition is the ultimate goal, but the use of calories in understanding foraging behavior has received criticism as we begin to understand how dietary macro- and micro-nutrient ratios affect health. However, very few studies actually report on the composition of foraged foods, even among well studied groups. This study works towards a more nuanced understanding of human foraging decisions, and explores the ways in which understanding the economic decision making process of modern foragers can inform our understanding of diet in the past.

**Contributions of brown adipose tissue to human metabolic adaptation: Comparative and evolutionary perspectives**

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Human responses to climatic stressors has long been a focus of research in biological anthropology and environmental physiology. Recently, there has been renewed interest in the study of metabolic adaptation to cold stress as the result of the discovery of active brown adipose tissue (BAT) in adult humans (J Nedergaard *et al.* 2007). Current research in nutritional science is examining whether BAT in adults can be stimulated to increase metabolic rates and help prevent or reduce obesity. Yet little attention has been given to larger adaptive/evolutionary questions of whether BAT levels are under selective control and vary with exposure to different climatic conditions. This paper will examine the importance of BAT for human responses to cold challenges throughout the life course, and consider the role that it may play in human adaptations to arctic climates.

Human infants are particularly vulnerable to the effects of cold stress, owing to their small body masses and high surface area to weight ratios. Consequently, BAT plays a critical role in thermoregulation during infancy, with modest cold challenges (~15C) resulting in a doubling of metabolic rates. Among adults, the presence of BAT varies considerably; individuals with significant depots of BAT show 15-20% increases in metabolic rates in response to cold, whereas those without BAT fail to mount a significant thermogenic response. Preliminary research among indigenous Siberian populations suggests that BAT may contribute to both their elevated rates of metabolism and their responses to severe winter-time cold.

**Y-Chromosomal Biogeography of *Cercopithecus mitis* in the Lomami Basin, Democratic Republic of the Congo**

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*Cercopithecus mitis* is a complex, polytypic guenon species that has a wide distribution throughout Africa. The *C. mitis* radiation has significant phenotypic and ecological diversity, making it a great candidate for evolutionary genetic studies. This study represents the first genetic survey of *C. mitis* from multiple well provenanced wild populations. Between 2008 and 2010, opportunistic tissue samples were collected from blue monkeys (*Cercopithecus mitis*) within the Lomami National Park in Central Africa's Congo Basin rainforest. DNA was extracted from the samples of 5 male individuals and surveyed at 900 bp of the gene for the Testis-Specific Protein, Y-chromosome (TSPY). These sequences were added to a larger TSPY dataset including *C. mitis* and *C. albobularis* specimens collected from multiple forest sites in Central and East Africa. Evolutionary analyses of the total TSPY dataset revealed two distinct Y-chromosomal lineages. One group clustered all *C. mitis* individuals from northeast of the Congo River. The 5 *C. mitis* individuals from the proposed Lomami National Park, however, clustered with *C. albobularis*. This Y-chromosomal pattern suggests that "Lomami" *C. mitis* may have shared more recent genetic contact with their *C. albobularis* neighbors at the headwaters of the Congo River than with conspecifics further to the northeast. If this inference is correct, it suggests that the Congo River is a significant biogeographic barrier to *C. mitis* and, further, opens speculation regarding the genetic heritage – and therefore proper taxonomic assignment and conservation status – of *C. mitis* in the Lomami National Park.

**A geometric morphometric analysis of prognathism and the gnathic index**

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Prognathism of the facial skeleton is often cited when examining population and ancestry differences in modern humans and evolution of the human cranium; however, classic methods do not define precisely the exact shape components contributing to mid-facial projection. Instead, such methods rely on relatively simple approximations such as the gnathic index, which compares basion-prosthion length to basion-nasion length in an attempt to quantify the general maxillary alveolar projection away from the rest of the face. This study sought to utilize geometric morphometric analyses to determine whether the gnathic index is actually a reliable indicator of all forms of subnasal prognathism. Nineteen craniofacial landmarks were collected from three-dimensional skull surface scans of individuals identified as U.S. White, U.S. Black, Portuguese, medieval Nubian, and Native American (N=114 males and 78 females).

Principal components were extracted from a generalized Procrustes analysis, and the resultant component scores were compared to gnathic index values. The results reveal that the gnathic index explains around 36% of the variance of PC1, which primarily captured shape changes related to subnasal prognathism ( $r = 0.604, p < 0.0001$ ). However, the gnathic index was also moderately correlated with PC2, which appears to reflect vertical changes to basion relative to the maxilla with no corresponding change in subnasal prognathism ( $r = -0.448, p < 0.0001$ ). These results suggest that the gnathic index may be influenced by relative differences in cranial vault and facial height, or cranial flexion between the two regions, and thus may not be an appropriate measure of prognathism.

**Latitude and Attitude: Eating insects in the Pleistocene and today**

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There is a considerable lack of insect consumption today in Europe and North America compared to other places around the globe. Often being dismissed as a cultural taboo, little has been done to investigate a possible evolutionary origin. As interest in this food resource increases due to its potential as a sustainable source of animal protein, researchers have started to collect more data regarding worldwide consumption. Countries with the highest level of insect consumption, measured by total number of species consumed, are located in tropical regions. Species consumed tend to decrease in a clinal fashion with increasing latitude. Ecological studies of insect diversity show that biodiversity decreases in a similar fashion, with the lowest biodiversity not surprisingly in the greatest latitudes. Therefore, the lack of insects in Western diets may have a much deeper origin than our present day cultures and may be related to insect availability upon arrival to the region. The patterns we see today may have origins in the Pleistocene with the last glacial period and the original spread of humanity.

**Eastern African carnivore guilds through time: integrating birds with hominins and carnivorans**

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The eastern African mammalian carnivore guild (including hominins and carnivorans) has been well-studied in comparison to the avian carnivore guild. This study uses ecological theory and the fossil record to place avian scavengers within a larger guild context.

Global species richness patterns of birds and mammals are strongly congruent. However, avian scavengers show the greatest richness



where there is a great diversity and abundance of large ungulates, as in eastern Africa today. Thus, the even greater diversity of large ungulates in the past indicates greater species richness of avian scavengers than today despite their poor fossil record.

By the time hominins evolved (5-7 Ma), many Miocene mammalian carnivores were extinct, while modern avian scavenger genera persisted despite turnover in other avian genera. During the Pliocene, carnivoran species richness peaked, signaling a high level of competition for carcasses. Pliocene avian scavengers are often immense, reflecting greater scavenging opportunities (enough to support their increased size) and the need to dominate competitors. Their presence must be accounted for when examining early hominin scavenging opportunities. After 3.0 Ma, carnivoran species richness declined permitting hominin niche expansion. While Oldowan tool usage had little effect on carnivorans, its avian impact is unknown. After further niche expansion to include more active hunting and scavenging (~1.8 Ma), hominins had a greater impact on carnivorans, leading to depauperate guilds today. Increases in hominin carcass utilization intensity probably negatively impacted avian scavengers, as well. More focus on the African avifauna will provide greater understanding of past carnivore guilds.

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**The evolution of subordination and social complexity: an analysis of power in Verreaux's sifaka**

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Unidirectional dominance-related signals can be used to communicate submission (an immediate behavior) or subordination (an institutionalized behavioral pattern). Subordination signals are emitted during peaceful interactions and are hypothesized to be critical for the evolution of social complexity and robust power structures because they reduce uncertainty in social relationships. The chatter vocalization in Verreaux's sifaka (*Propithecus verreauxi*) is a unidirectional submissive signal. To test the hypothesis that chatter vocalizations signal subordination and reduce agonism in a dyad, I examined 780 chatters from 18 dyads collected over 880 observation hours on 5 groups of sifaka in Kirindy Forest, Madagascar. Ninety-four percent of dyads exhibited chatters in the peaceful context, indicating that sifaka communicate about behavioral patterns rather than just immediate behaviors. Peaceful chatters in dyads significantly predicted groom rates, proportion of wins by dominants, and reconciliation but not fight rates. Thus,

subordination signaling does not reduce conflicts in sifaka but does increase tolerance and affiliation when conflicts occur. Dyad type significantly predicted the frequency of peaceful chatters, with intrasexual dyads exhibiting chatters in peaceful contexts more often than intersexual dyads. Hence, intrasexual power may be more institutionalized than intersexual power. Sifaka have low rates of social interactions and while coalitions occur, they are uncommon. Therefore, the finding that subordination signaling is nearly ubiquitous in this lemur and less common in macaques suggests that triadic interactions may be less important for the evolution of social complexity than is currently thought and highlights the importance of studying social complexity in a variety of taxa.

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**Morphological convergence in the pelvis of slow-moving sloths and lorises**

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The loris pelvis is characterized by long pubic rami and rod-like ilia, but the functional morphology of these features has received little attention. These long pubic rami may be related to increasing the moment arm of the thigh adductor musculature during sustained, slow-twitch muscular contractions that occur during their characteristic form of slow arboreal quadrupedalism (AQ). Sloths and anteaters (Order Pilosa) are also slow AQ taxa, and provide an ideal group to test hypotheses of morphologically convergent adaptations to slow locomotion. This study tests such hypotheses in two species of sloths (*Bradypus* and *Choloepus*), the pygmy anteater (*Cyclopes*), and two species of slow loris, and makes comparisons to 38 other species of primates. Geometric morphometric methods were used to analyze 27 three-dimensional pelvic landmarks, and a principal component analysis demonstrates substantial overlap among lorises, sloths, and humans along PC2 only (12% of sample variation). Mean shape configurations suggest that similarities among these overlapping species are long and robust pubic rami. Regression and ANOVA on nine interlandmark distances confirmed that sloths and anteaters share with lorises long pubic rami and short pubic symphyses, which supports the hypothesis that these features are functionally related to slow locomotion. Additional data are needed to determine whether convergent pelvic morphologies are related to sustained contractions of hip and thigh musculature, or to other aspects of locomotor mechanics related to postural loading. In addition, future research is required to determine the possible functional relevance of this study's other findings of similarities between sloths and humans.

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**Dental Microwear Analyses and Dietary Reconstruction at Haminmangha, a Neolithic Site in Inner Mongolia, China**

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Dental microwear analyses and Stable isotope are integrated to determine diet at the prehistoric site of Haminmangha, China, 5500-5000 B.P. The Haminmangha site is located in Inner Mongolia and belongs to the middle Neolithic culture. The evidence for reconstructing diet of the Haminmangha population can be obtained by dental microwear analysis directly and effectively. Dental microwear analysis focuses on the microscopic scratches that formed on tooth's surface as the result of chewing. Different microwear patterns of scratches on the buccal surface indicate different dietary composition. In this study, scratches of the buccal surface have been studied on molars from the Haminmangha site. All samples have been observed at 200X magnification by scanning electron microscope. The length and orientation of each scratch on the buccal surface have been determined and measured. The results obtained show that people of the Haminmangha site ingested both animal products and plant products. This result is concordant with the result of stable isotope analysis. We use stable isotope ratios of carbon and nitrogen in bone collagen to examine the diet of the Haminmangha population. Nitrogen isotope ratios of bone collagen also show that these inhabitants ate animal products and plant products. Carbon isotope ratios of bone collagen show that plant products came from C4 plants and C3 plants. That means subsistence of the Haminmangha population included hunting and gathering. This study demonstrates the importance of integrating different analytical methods when reconstructing diet of prehistoric populations.

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**The establishment of the Chinese Human Skeleton database based on the FileMaker**

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Chinese academic institutions like Chinese Academy of Sciences, Jilin University have a large collection of ancient human bones. However, we still lack an online database like Human Skeleton Archaeology. Frontier Archaeology Research Center of Jilin University



is engaged in using FileMaker database to design and establish such a database as a new approach to prompt the data interflow of bioarchaeology in China. Firstly, the research center has not only more than twenty thousand precious human bone specimens, but also many high-tech equipment. Besides, Jilin University has close interdisciplinary cooperation with other Chinese universities. The information currently obtained by analyzing anthropological specimens is fragmentary and unsatisfactory. But the use of this database will change the status quo. Basic data of human bone and the knowledge delivery means is blocked among various research institutions, which makes researchers repeatedly measure the same data and even causes secondary damage to precious specimens. The anthropological database built on FileMaker database can be shared between many users and everyone can log on the database directly. Moreover, Chinese academic institutions own different kinds of precious specimens, it often takes researchers lots of time to look for a particular one. Once the anthropological database established, the relevant researchers can turn to it and find what they need. Based on the FileMaker, anthropological database will provide us with a visual and descriptive communication platform, which will play an important role in the development of physical anthropology.

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#### **Testing the effects of shoes on foot strength, stiffness and function**

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Most data on locomotor biomechanics derive from studies of habitually shod subjects, but cushioned, supportive shoes have become common only recently. Therefore, in order to evaluate hypotheses about the evolution of human locomotion, it is necessary to understand how shoes affect normative foot function during locomotion. We tested foot strength, foot stiffness, and lower extremity kinematics during walking and running gaits in a sample of 48 habitually barefoot and shod Kalenjin-speaking Kenyans and 23 Tarahumara Native Americans, who were habitually shod either in minimal sandals (*huaraches*) or conventional shoes. Sources and levels of variation in running form were experimentally manipulated, including speed, surface hardness, and stride rate. In both populations, conventionally shod individuals had approximately 50% less arch stiffness, and significantly less variation in arch height. In terms of kinematics, barefoot and shod individuals almost always rearfoot strike when walking, as do most runners in shoes with thick heels. However, strike types among habitual

barefoot runners were significantly more variable. A general linear model indicates that foot strike angle was significantly affected by surface hardness, footwear history and running history, but not speed, with habitually barefoot individuals more likely to switch to mid- or forefoot strikes on harder surfaces. Strike type also covaries significantly with kinematics including trunk posture, preferred stride rate and degree of overstride. These results indicate that modern, habitually shod populations exhibit more variability in foot structure but less variation in gait kinematics, hence more variation in the forces acting on the lower extremity.

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#### **Associations between socioeconomic status and obesity in low- and middle-income countries: Results from the Study on global AGEing and adult health (SAGE)**

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Recent studies have documented complex relationships between socioeconomic status (SES) and obesity, with level of economic development and sex structuring the directionality and strength of associations. Evidence suggests that SES and obesity are negatively associated in higher-income countries but positively associated in lower-income countries; however, few studies have evaluated these links among older adults in low- and middle-income countries. Here, we use the Study on global AGEing and adult health (SAGE) data with nationally-representative samples of older adults ( $\geq 50$  years old) in China, Ghana, India, Mexico, Russian Federation, and South Africa to examine the relationship between SES and obesity. Body mass index (BMI) and waist circumference (WC) were measured to quantify obesity levels. SES was determined through self-reported income and education. Linear regressions estimated the contribution of income and education to BMI and WC while controlling for age, physical activity, smoking, drinking, and marital status. Analyses were conducted separately by country and sex. Among men, BMI and WC were positively associated with income in all countries except Russia, while BMI and WC were positively associated with education in India, Ghana, and China ( $p < 0.05$ ). BMI and income were positively associated among Russian women ( $p < 0.05$ ). Results suggest that high SES may increase obesity risks for older men in middle-income countries. The findings in women may imply a shift in the relationship between SES and obesity due to societal and nutritional changes associated with globalization. This study highlights the importance of the

socioeconomic context of obesity among aging populations from middle-income countries.

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#### **Flowers or figs: Dietary choices in wild white-handed gibbons (*Hylobates lar*) in western Thailand**

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Gibbons are often characterized as being highly adapted to feeding on ripe fruit; however, considerable variation exists between gibbon species, between habitats, and in response to seasonal variation. To determine the role of habitat on gibbon diet, I compared the feeding behavior of gibbons occupying distinct habitats in the Huai Kha Khaeng Wildlife Sanctuary. Gibbons here live in both evergreen and mosaic forest areas, which consist primarily of mixed deciduous and deciduous dipterocarp forests where food resources are highly variable in both time and space. I hypothesize that these conditions will result in important differences in gibbon diet between habitats.

Data were collected on four gibbon groups from June 2012-May 2013. Groups living in mosaic forest areas overall ate less fruit (63.4% vs. 72.6%) and insects (4.5% vs. 5.3%) and more leaves (20.7% vs. 16.2%), flowers (4.6% vs. 2.7%), and vine shoots (5.8% vs. 1.5%). Seasonal differences in food choice were marked in both habitats. Monthly fruit consumption ranged from 19.7-80.0% (mosaic) and 48.3-95.2% (evergreen). Leaves always comprised at least 5% of the diet for both habitat types, but totaled 57.7% of the mosaic diet in January and 41.6% of the evergreen diet in May. While flowers never comprised more than 10% of the diet in evergreen groups, they contributed 38.1% of the mosaic diet in March. Furthermore, mosaic gibbons were observed consuming bird's eggs on two occasions in April. These results confirm growing recognition that gibbons are more ecologically flexible than once believed and highlight the importance of intraspecific comparisons.

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**The ecology of fear and savanna resource limitation in western chimpanzees (*Pan troglodytes verus*) at Fongoli, Senegal**

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A chimpanzee's home range includes not only the base layer of desirable, consumable resources, but is also composed of a second layer that comprises the chimpanzee's perception of its risk of mortality due to predators of various species. These layers contribute to the spatio-temporal patterns of costs and benefits that the chimpanzee might expect to encounter across its home range. In this study, we assessed how resources and risk concomitantly shape the foraging behavior of western chimpanzees (*Pan troglodytes verus*) at Fongoli, Senegal. As desired resources were in risky areas of their home range, particularly near anthropogenic landmarks, we hypothesized that males would avoid these areas unless the benefits outweighed the costs. Food intakes and intake rates of males (N=11) were compared to risky areas of their home range and behavioral indicators of perceived risk. Furthermore, we compared feeding behavior to habitat and proximity to surface water. Males increased intake rate in open habitats (Kruskal-Wallis  $\chi^2=6.35$ ,  $df=1$ ,  $P=0.01$ ) and consumed less food as the distance to drinking water increased (Spearman's  $\rho=-0.23$ ,  $P<0.05$ ). Such adjustments might offset the metabolic cost of feeding in exposed areas, or reduce the risk of dehydration, respectively. Individuals displayed antipredator behavior towards people but rather than truncate a feeding bout, adult males ingested more food (Kruskal-Wallis  $\chi^2=6.58$ ,  $df=1$ ,  $P=0.01$ ) and increased foraging party size (Spearman's  $\rho=0.26$ ,  $P<0.05$ ). Although people rarely hunt chimpanzees in Senegal, we show that they perceive humans as predators and adjust their behavior in response to this risk.

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**Resurrecting lives: a contextualized data analysis and collaboration exercise in a bioarchaeology seminar**

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As collaboration and large datasets become the norm in bioarchaeological research, the successful design and execution of a robust study ultimately depends on the ability to devise, manage, explore, analyze, interpret, and disseminate the data. An exercise was implemented in an upper-division bioarchaeology seminar at Appalachian State University highlighting the critical role of

contextualized data interpretation and management, concurrent with the bioarchaeological concepts traditionally taught. Each student first explored, analyzed, and interpreted a subset of the post-medieval Crossbones Cemetery data accessible on the Centre for Human Bioarchaeology (Museum of London) website, for three skeletal-dental markers of their choice. Site and excavation context, coding standards, and associated images were provided. Students collaborated in supplementing the relevant epidemiological and historical contexts. At midterm, student each proposed, peer-evaluated, and improved upon two sets of "big-picture" question, rationale, and design based on their subset. After the instructor's approval, each student proceeded with one of the proposed projects using the entire Crossbones dataset. Students were evaluated again at final for research logic, statistical robusticity, and the ability to parsimoniously extrapolate the data to reconstruct the lifeways of post-medieval England.

This exercise simulated the scientific inquiry process by integrating bioarchaeological concepts and phases of data assessment. Students appreciated the forethoughts dedicated to constructing and maintaining a transferable database and the necessity for standardized recording methods the most. Students without field training experienced more difficulties synthesizing the sociocultural context and the data, underscoring the indispensability of excavation methods that should be tightly integrated in undergraduate bioanthropology curricula.

**Stature reconstruction from long bones in population of the South-central Inner Mongolia from Bronze Age to Early Iron Age**

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The South-central Inner Mongolia area is an important component of the farming-pastoral ecotone in northern China. The archaeology study in this area from Bronze Age to early Iron Age could lead to a better understanding of the development of the ecotone. The point of this research is to rebuild the stature of ancient human through their limbs utilizing regression methods. The result shows that the stature of the inhabitants in South-central Inner Mongolia was medium compared to other populations' at the same time around this area. It also indicated that the subsistence pattern and environment may have an influence on the stature.

**Human molar formation overlap**

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Overlap in formation times between sequential molars is important when interpreting juvenile fossil hominins, however, few studies report variation in the initiation of M2 relative to M1, and M3 relative to M2. The aim of this study was to describe formation stages of mandibular molars at early stages of M2 and M3. The sample of 2740 individuals aged 2-22 years was drawn from an archive of retrospective, cross-sectional, panoramic dental radiographs. Left mandibular molars were assessed using tooth stages described by Moorrees, Fanning and Hunt with the addition of crypt stage. The range and modal stage of M1 was described at the first three M2 stages (crypt, initial mineralisation and coalescence of cusps). Similarly, the range and modal stage of M2 was described at the first three M3 stages. Results show that M2 crypt stage was observed from M1 C1/2 to R1/4 with modal stage Cc (N=87). M2 Ci was observed from M1 C3/4 to R1/4 (N=135), modal stage Cc. The range at M2 Cco was M1 Cc to R1/2 (N=180), modal stage root cleft. The crypt of M3 was observed from M2 C1/2 to R3/4 (N=181), modal stage Cc. Initial mineralisation of M3 was seen from M2 Cc to R1/2 (N=100), modal stage R1/4. The range of stages at M3 Cco was M2 Cc to late root stages (N=112), modal stage R1/4. These findings show that crypt stage is more variable than Ci and that M3 initiation is relatively delayed compared to M2.

**Cheek pouch use in wild Sanje mangabeys (*Cercocebus sanjei*), Udzungwa Mountains, Tanzania**

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Cheek pouch use in primates is relatively poorly studied, despite being a major taxonomic indicator of the subfamily Cercopithecinae, and the adaptive role of cheek pouches remains unresolved.

Cheek pouch use may limit conspecific feeding competition by facilitating rapid collection of food items and diminishing the likelihood of a physical encounter. To investigate whether cheek pouch use in the Sanje mangabey (*Cercocebus sanjei*) functions to reduce within-group feeding competition, we tested for differences in cheek pouch use by age/sex class and female dominance rank, and distance to nearest neighbor and number of neighbors when using cheek pouches compared to feeding directly. Lastly, we examined whether the food types and species of dietary items commonly placed within cheek pouches were expected to elicit contest competition between individuals.

Behavioral data of adults, sub-adults and juveniles were collected using focal animal sampling between December 2010 and November 2011, from a habituated mangabey

group (n=69) in the Udzungwa Mountains National Park, Tanzania.

No significant differences were found in cheek pouch use by age/sex class ( $p=0.991$ ), female rank category ( $p=0.675$ ), or in distance to nearest neighbor ( $p=0.236$ ). Contrary to expectation, a significant decrease occurred in the number of neighbors when filling cheek pouches compared to feeding directly ( $p=0.0004$ ). While the majority of cheek-pouched foods were ripe fruits (82.55%), these included several species that required extra masticatory processing and only two highly contested fruit species.

These preliminary results suggest that cheek pouch use in this species does not serve primarily to mitigate inter-individual feeding competition.

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**The present informs the past: incorporating modern clinical data into paleopathological analyses of metabolic bone disease**

LAURA LOCKAU. Anthropology, McMaster University.

Paleopathology, the study of disease in antiquity, exists at the intersection of medicine and anthropology; the contextualization of clinical data with anthropological theory forms the basis of paleopathological contributions to the understanding of metabolic bone diseases, including vitamin D deficiency (rickets and osteomalacia), vitamin C deficiency (scurvy), and osteoporosis. However, perceived dichotomies between method and theory, biology and culture, description and interpretation, and process and categorization serve to reinforce pervasive conceptions of the two fields as contrasting rather than collaborative. Significant differences exist in the evidence, methodologies, and approaches available to clinicians and to paleopathologists, and these differences affect how clinical data can be utilized in paleopathology. This poster examines the ways in which published paleopathological analyses of skeletal evidence for metabolic bone disease have applied clinical data in order to disclose attitudes toward the relative value of clinical approaches to and understandings of metabolic bone disease for paleopathological analyses. By examining how paleopathologists have approached the integration of clinical information, this project reveals the significant contributions that clinical data, technologies, and approaches have made to understandings of metabolic bone disease, as well as the limitations associated with applying clinical information in this context. This research suggests that more direct engagement of paleopathological analyses with clinical data as well as clear dialogue between the two fields to clarify the aims and

interests of each will contribute to the development of a truly mutually beneficial relationship, aimed at gaining an improved understanding of past and present metabolic bone disease.

**Patterns of taxonomic diversity and relative geographic occupancy of Mio-Pliocene crown Catarrhini**

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Of the extant Old World primates, cercopithecoids are significantly more widespread, species-rich, and ecologically diverse compared with living hominoids, but their taxonomic and ecological dominance has occurred relatively recently. This study uses measures of relative number of occurrences and relative range area to describe the known geographic distributions of hominoids and cercopithecoids during the Mio-Pliocene, and compares changes in these distributions with shifts in taxonomic richness within these groups. A shift from an Old World primate fauna characterized by greater hominoid richness to one with greater cercopithecoid richness occurs in the Late Miocene, concomitant with a decline in hominoid geographic range and dramatic increase in cercopithecoid range. The increased area inhabited by cercopithecoids can be primarily attributed to the rapid range expansion of early colobines, which is unexpectedly large relative to their low richness, suggesting a small number of taxa were able to inhabit a wide variety of habitat types across a large area.

These results imply that the expansive geographic range of hominoids in the Middle Miocene was a function of their high levels of taxonomic diversity, and that they became geographically restricted as this diversity was lost during the Late Miocene. This contrasts with the geographic expansion of cercopithecoids, particularly the colobines, which was decoupled from changes in taxonomic diversity. This study lends support to previous hypotheses that greater ecological flexibility allowed cercopithecoids to persist and even flourish through the series of major climatic events in the Late Miocene.

**Population structure beyond that detected using model-based clustering**

JEFFREY C. LONG, JESSICA M. GROSS, ANTHONY J. KOEHL and SARA D. NIEDEBALSKI. Anthropology, University of New Mexico.

Geneticists often apply clustering methods to genomic data to find subgroups of people in large databases. The program *structure* is a popular method. The algorithm in *structure* assigns each person to one subgroup, or to a

mixture of subgroups. Researchers usually infer that this clustering detects genetic populations. A notable finding from this kind of analysis is that when researchers place people in a worldwide sample into five subgroups, the group membership captures the continental origins of the people. This result has intuitive appeal. However, it tells us little about patterns of diversity or individual relationships.

We suggest that future anthropological research go beyond simple cluster analysis. To illustrate strategies, we further analyze the original data that yielded the five-cluster pattern. The data contains genotypes for each of  $N=1056$  people. Each person was typed at 377 autosomal short-tandem repeat loci. Each sampled person belongs to one of 51 groups that live in Africa, Europe, Asia, or the Americas. We found from statistical analysis of genetic distances that each group represents a distinct gene pool. We also found a nested model that explains 95% of the deviations from the  $K=5$  groups clustering model. Next, we analyzed the genetic kinship between all 557,040 pairs of individuals. We see that different levels of within group genetic kinship typify the clusters. Pairs of people from different clusters may be as related as pairs from the same cluster. We explain our findings using the serial founder effects model.

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**The biogeographic origins of major primate clades**

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The biogeographic origins of Primates has received relatively little attention in the literature. Likelihood methods have been suggested to give better results for ancestral area reconstruction than parsimony. However, past studies using likelihood have not included fossils, failing to consider the full biogeographic range of Primates through time.

A likelihood analysis based on a supertree with 488 primate taxa, including 134 fossils, was performed to test hypotheses of ancestral areas. The results show significant differences from previous analyses that did not include fossils. Both Primates *sensu lato* (including Plesiadapiformes) and Euprimates are inferred to have originated in North America, supported by the presence on that continent of the oldest groups of plesiadapiforms, omomyoids, and adapoids. Strepsirrhini *sensu lato* (including adapoids) appears to be Asian in origin, in opposition to previous analyses that have considered them Malagasy, Eurasian, and/or African. This results from the presence in Asia of primitive adapoids. In contrast, crown



## AAPA Abstracts

strepsirrhines are inferred to have originated in Africa. The place of origins of Anthropoidea remains uncertain, but none of the most likely resolutions include Africa. In terms of apes, while pongines probably originated in Eastern Asia, the African ape-human clade most likely originated in Europe or in Western Asia (i.e. Anatolia), not in Africa as some have previously inferred. Adding data on fossil primates significantly changes the ancestral areas reconstructed relative to previous analyses that used likelihood methods, demonstrating that extinct forms are critical to performing accurate ancestral area reconstructions.

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**Falling back on natural forage when the dumpster is empty: an examination of the nutritional and mechanical properties of foods consumed by free-ranging chacma baboons (*Papio ursinus*)**

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Like many omnivorous primates, chacma baboons (*Papio ursinus*) appear to prefer human foods to the natural forage that is available in their environment. Several human foods and crops are rich in nutrients, flavorful, and easy to process. Here we present preliminary data regarding the behavioral ecology of free-ranging baboons inhabiting a reserve in the Cradle of Humankind in South Africa. The reserve includes a restaurant and as a result the baboons consume human foods from two dumpsters. We examine the mechanical and nutritional properties of human foods (i.e. refined sugar, breads, game and domesticated meats, eggs, and cultivated fruits and vegetables) and naturally occurring plants consumed by these baboons. The mechanical properties (Toughness J/m<sup>2</sup>, Young's Modulus, and Hardness values) of some of the wild foods consumed by the baboons are similar to those reported for free-ranging gelada baboons (*Theropithecus gelada*). Using near-infrared reflectance spectroscopy (NIRS) we analyzed the nutritional properties of human foods and wild forage. We also analyzed the mechanical and nutritional values of wild plants within our botanical transects and located on the landscape. The activity patterns of these baboons were largely determined by the dumpster foods. Comparatively, the day ranges were small (~3.6 km) and consisted primarily of walking from their sleeping sites outside the reserve to the dumpsters to feed in the morning hours. We hope that these data will broaden our understanding the feeding patterns of baboons as well as those

of the early hominins that once utilized these landscapes.

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**Neanderthal and Denisova genetic affinities with contemporary humans**

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Analyses of the genetic relationships and interactions among modern humans, Neanderthals and Denisovans have suggested that 1-4% of the non-Sub-Saharan African gene pool may be Neanderthal derived, while 6-8% of the Melanesian gene pool may be the product of admixture between the Denisovans and the direct ancestors of Melanesians. In the present study, we utilize genetic structure analysis to examine the relationships among a worldwide collection of contemporary humans, Neanderthals, Denisovans, and *Pan troglodytes*. The unique advantage of structure analysis is that it uses allelic frequency trends among populations to find remnants of gene pools, which contributed to these populations in the past. To accomplish this we use 37,758 single nucleotide polymorphisms (SNPs), conducting separate examinations of subsets of mutations with higher probabilities of divergent phylogenetic origins. We additionally include common ancestral SNPs in our analyses to more accurately visualize potential gene flow. Our results indicate that 3.6% of the Neanderthal genome is shared with roughly 65.3% of the average European gene pool, which clinally diminishes with distance from Europe. This may be alternatively reflect an unprecedented level of highly regionalized admixture, or common ancestry influenced by genetic drift. However, the genetic affinities observed between Denisovans and Melanesians appear to result from the retention of ancient mutations in these populations.

**The Tana River red colobus (*Procolobus rufomitatus*) exhibit behavioral flexibility to changes in habitat quality; a longitudinal and spatial comparison of behavioral ecology**

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The endemic Tana River red colobus (*Procolobus rufomitatus*) inhabits riverine forests with a history of natural and anthropogenic disturbances. Following decades of extensive changes in their habitat, this study examines their current behavioral ecology in differentially disturbed forest patches (i.e. primary growth Mchelelo vs. human-disturbed Ntuneni), comparing previously published reports with current local population density, group sizes and composition, activity budgets, and phenological data at the two sites. Due to long-term habitat changes, we predicted that a longitudinal comparison would yield: a) significant differences in group activity budgets and b) greater habitat availability for current study groups due to forest regeneration with larger home ranges (HR), but shorter daily travel lengths (DTL). Current activity budgets differed significantly from previous reports for moving ( $\chi^2=22.635$ ;  $p<0.0001$ ) and feeding ( $\chi^2=33.020$ ;  $p<0.0001$ ) but not in percent time resting; however, HR and DTL were similar (NS). Due to differences in habitat quality between Mchelelo and Ntuneni, we also predicted that the two current study groups' activity budgets would differ, with colobus in Ntuneni resting and feeding more, and engaging in other behaviors less frequently. Indeed, their activity budgets differed significantly in the directions predicted ( $\chi^2$ ,  $p<0.0019$ ), as did their DTL. Hence, these findings demonstrate that the Tana River red colobus exhibit behavioral flexibility and are able to adapt to their changing habitat. The current study also reveals the importance of properly managing both intact primary forest patches and disturbed forest landscapes for land-use planning and the conservation of the Tana River red colobus.

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**Comparing the face to the body, which is better for identification?**

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In the 19<sup>th</sup> century, A. Bertillon advocated use of measurements of the face and body for forensic identification because no two individuals had the exact same measurements. This approach was overtaken by fingerprint analysis considered more reliable as the probabilities of finding matching individuals could be calculated. Face photographs were also used for identification. With the ability to take measurements from photographs probabilities of finding matching



individuals can be calculated. Criminals, and others, cover their faces to avoid identification. Surveillance videos often depict entire bodies. Thus body measurements can be used for identification. We used ANSUR database containing face and body measurements of 3982 individuals. Eight facial and eight body dimensions were compared to investigate reliability of identification. In a stepwise approach combinations of measurements were constructed until there were no duplicate cases where at least two individuals share exact dimensions. A combination of 8 face measurements provided a  $10^{-14}$  probability of finding a duplicate. Similar probability was achieved with a combination of just 5 body dimensions, while 8 body dimensions produce even lower probability of finding a duplicate to the order of  $10^{-20}$  or 1 in a quintillion. Thus body dimensions are a better identifier than the face measurements. This is so because the intervals of body dimensions are greater giving more units to combine. These results are comparable with fingerprint analysis. An advantage to using the body is that larger dimensions are easier to locate on images and are not affected by facial expression.

**GIS analysis of habitat usage by sympatric southern lesser (*Galago moholi*) and thick-tailed galagos (*Otolemur crassicaudatus*) in an Afromontane environment**

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Southern lesser galagos (*Galago moholi*) and thick-tailed galagos (*Otolemur crassicaudatus*) are found in southern Africa, but may prefer different habitat types. *G. moholi* are reported from Acacia woodland habitats while *O. crassicaudatus* are described in woodland, riverine, and forest edge habitats. However, few studies have examined both species in sympatry. Given the differences in habitat use for allopatric *G. moholi* and *O. crassicaudatus*, the two galagos may occupy different habitat types and not share overlapping ranges in areas of sympatry. We investigated the potential for these species to specialize on different habitat types at the Lajuma Research Center in Limpopo Province, South Africa.

To investigate this hypothesis, we trapped and censused galagos between 10 June and 10 July 2013, and 6 to 30 July 2014. When galagos were either trapped or observed during census walks, their location was recorded on a handheld GPS unit. Five line transects 100 m in length were established in the reserve for habitat description. Tree dbh, height, and species were recorded for sampled trees along transects. This information was used to classify habitat type for each

transect. With this information plotted in ArcMap, we cross-referenced the location of each galago sighting or capture with the habitat type in which it was located. We then performed a regression in SPSS, which revealed there is no significant relationship between either species and a specific habitat type, suggesting they do not specialize by habitat type in areas of sympatry.

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**Dynamics of cultural transmission in Native Americans of the High Great Plains**

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Culture is a phenomenon shared by all humans. Attempts to understand how dynamic factors affect the origin and distribution of cultural elements are, therefore, of interest to all humanity. As case studies go, understanding the distribution of cultural elements in Native American communities during the historical period of the Great Plains would seem a most challenging one. Famously, there is a mixture of powerful internal and external factors, creating—for a relatively brief period in time—a seemingly distinctive set of shared elements from a linguistically diverse set of peoples. This is known across the world as the “Great Plains culture.” Here, quantitative analyses show how different processes operated on two sets of cultural traits among nine High Plains groups. Moccasin decorations exhibit a pattern consistent with geographically-mediated between-group interaction. However, group variations in the religious ceremony of the Sun Dance also reveal evidence of purifying cultural selection associated with deep historical roots dividing down ancient linguistic lines. The latter shows that while the conglomeration of “Plains culture” may have been a product of merging new ideas with old, combined with cultural interchange between groups, the details of what was accepted, rejected or elaborated in each case reflected preexisting ideological biases. Although culture may sometimes be a “melting pot,” the analyses show that even in highly fluid situations, cultural mosaics may be shaped by historical factors that are not always obvious.

**Neotropical primate biogeography: A synthesis**

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Life Sciences, University of Salford, <sup>6</sup>INPA, Instituto Nacional de Pesquisas da Amazonia.

Recent phylogenetic divergence time estimates and statistical phylogeographic studies have greatly improved our understanding of the evolutionary history of the New World monkeys. However, most biogeography studies have focused at the within genus level, with limited attention to comparing patterns across Neotropical primate genera. Here we synthesize data from across all genera to provide insight into multiple platyrrhine radiations, diversifications, extinctions, and recolonizations over time and space and offer a comprehensive hypothesis for platyrrhine evolution and diversification. We explore the current controversy about how the Amazon River system has shaped platyrrhine diversity; we highlight the evidence for primate colonizations and extirpations in Central America, the Andes, and the understudied seasonally dry tropical forests of the Chaco, Caatinga, Cerrado, and Llanos; and we summarize estimated divergence times between sister taxa in the Amazon versus Atlantic Forest. Major findings include strong evidence for: an Amazonian origin and long-term tropical habitation for Neotropical primates; multiple Miocene expansions from the Amazon to the Atlantic Forest, with more recent Pleistocene diversification within the Atlantic Forest; and several waves of entry into Central America following the formation of the Isthmus of Panama rather than simultaneous colonization by all primate genera. We also conclude that current occupation of seasonally dry forests by platyrrhines is usually due to recent expansion from rainforest habitat. Finally, we highlight cases where ecological divergence has allowed closely related genera to re-enter into sympatry with one another, with a focus on: *Cebus* versus *Sapajus*; *Leontocebus* versus *Saguinus*; and *Callicebus* sensu lato.

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**Survival of calcified atheromata in the archaeological record - The effect of taphonomy, excavation and curation strategies on preservation and analysis**

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While organic remnants of the cardiovascular system are unlikely to survive, advanced stages of atherosclerosis, one of the most common forms of cardiovascular disease (CVD) lead to the formation of calcified plaques. The potential of survival of the plaques, biochemically similar to bone, has long been recognised. Nevertheless, evidence for CVD associated with human skeletal remains, the predominant source of data

## AAPA Abstracts

bioarchaeologists work with, is still almost absent. In light of recent research and considering the known risk factors such as a high-cholesterol diet, chronic inflammation and dental disease, all of which well evidenced in archaeological human remains, a mere absence of CVD in the past seems unrealistic. Rather, their apparent lack is may be explained by 1) taphonomic reasons leading to differential preservation of calcifications and 2) insufficient recovery strategies during archaeological excavation. In order to extend the dataset of evidence for CVD in the past, it is crucial these factors are addressed in bioarchaeological research.

Taphonomic factors are addressed through comparison of findings of different types of pathological calcifications, used as a proxy for arterial plaques, from various geographical and chronological contexts. This reveals the potential of survival of calcified structures under different 'environmental' conditions worldwide. Based on field observations during excavations in cemeteries in Sudan (1300–800BC), recommendations are formulated that may aid in recovering calcified atherosclerotic plaques. These include sieving, basic knowledge of the cardiovascular system and morphology of calcifications, and where these may be found in graves.

#### **Anemia, stress, and mortality in an historic Portuguese skeletal sample**

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This study investigated incidence and severity of *cribra orbitalia* (CO) and *porotic hyperostosis* (PH) as indicators of stress and adaptation in an historic Portuguese population at the Bocage Museum in Lisbon, Portugal. The Luis Lopes collection originates from modern cemeteries and represents a socioeconomically impoverished portion of society. Crania were scored ( $n=540$ ) using the Global Health History Project (Steckel and Rose 2002) guidelines for macroscopic analysis. Incidence and severity were compared between sex, age, and cause-of-death. The sample yields complex data that may best be explained by the *Osteological Paradox* (Wood et al. 1992). Contrary to hypotheses that females and children would show a greater frequency of lesions based on bioarchaeological and clinical research of iron deficiency related to child-rearing and early development, males showed a higher incidence of PH, combined lesions, and a younger mean age-at-death. PH is the least represented lesion type in the sample, but the strongest informant of increased mortality. Early adolescence (11-15 years) and early adulthood (36-40 years) age cohorts show the highest mean incidence of PH and concurrent expression. The mortality risk corresponds to the

Gompertz Hazard model, which plotted a survivorship curve below the overall hazard of dying until age forty. Individuals without lesions in later adulthood likely experienced remodeling of affected areas, never experienced skeletal impact of poor iron metabolism, or succumbed to ailment before immunodeficiencies displayed skeletally. Macroscopic analyses are informative and methodologically more approachable, but future research necessitates microscopic and genetic investigation of iron metabolism in the skeletal record.

*This project was facilitated by grants to Samantha M. Hens from the UEI Faculty Grants Program, College of SSIS, and Office of Research and Sponsored Projects, California State University, Sacramento.*

#### **Musculoskeletal growth patterns in wild chimpanzees (*Pan troglodytes*)**

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Developmental data from our closest living relatives are of particular interest for identifying which aspects of human life history are derived. To date, most of our knowledge of chimpanzee growth comes from data on captive populations despite indications that these individuals develop faster than their wild counterparts. In this study, we examine patterns of growth among wild chimpanzees of the Kanyawara community in Uganda. From 2012-2014, body size estimates were acquired for over 50 individuals using parallel laser photogrammetry to calculate trunk lengths (as measures of linear growth) and cross-sectional trunk area (as an approximation of body weight). Two important patterns of chimpanzee growth emerge from this study. First, compared to captive populations, wild chimpanzees exhibit a delayed adolescent growth spurt as well as an extended adolescent growth period. Second, male body size measures indicate that 10-year olds maintain body lengths within the range of those exhibited by adult males, but their body areas fall below the adult male range and only reach adult sizes between the ages of 15-17. This indicates that skeletal growth is likely completed before the addition of muscle mass for these males. These results call for a re-evaluation of using captive chimpanzee growth estimates as a model for the ancestral hominin growth pattern and suggest that wild chimpanzee and human growth patterns are more similar than previously expected. They also demonstrate an important difference between skeletal and muscular growth that needs to be

considered in studies of human life history evolution.

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#### **Skeletal growth impairment and subsequent recovery with the introduction of agriculture in Central Europe**

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The adoption of agriculture marked a fundamental shift in human subsistence that drove heterogeneous and regionally variable trends in body size worldwide. Skeletal growth impairment has been documented in some early agricultural groups, while body size in others increased or was not affected. The proximate and long-term effects of the transition to agriculture on body size in Central Europe are not well characterized. In this study, adult stature and body mass index (by proxy) are tracked in 408 adult hunter-gatherers and farmers through ~7950 years of cultural and subsistence change in Central Europe (~7100 BC - 850 AD). The introduction of farming in the Early Neolithic in Central Europe was associated with reductions in stature in both sexes, significantly so in males. Stature had largely recovered by the Bronze Age, on average returning to pre-farming estimates among females. On either side of the transition to agriculture, body mass was similar for a given height among both males and females. However, by the Iron Age, females were significantly heavier for a given height than both Mesolithic hunter-gatherers and Neolithic early farmers. Results suggest that the initial transition to farming in Central Europe was associated with growth impairment, predominantly in males, but that once farming was established, it was in females that skeletal growth and body mass in relation to height particularly increased. These changes in body size may be associated with improved nutrition and health, changes in behavior, genetic differences in build, or a combination of these factors.

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**The ecological niche of the *Morotopithecus*, with implications for hominoid evolution**

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The Moroto II locality in Uganda, dated to > 20.6 Ma, is best known for the presence of the hominoid *Morotopithecus*. Recently, dental fossils from the site have revealed evidence for folivory (e.g. a long tooth row, and a large, narrow M<sub>2</sub> with well-developed cristids). Additional recovery of femoral fragments have completed the shaft of MUZM 80, indicating that *Morotopithecus* had a short shaft relative to femoral joint proportions, as in other hominoids and unlike *Proconsul* and cercopithecoids. This corroborates earlier interpretations that *Morotopithecus* loaded the hindlimbs and forelimbs differentially in behaviors including orthograde slow climbing.

It has seemed incongruous that *Morotopithecus*, as one of the oldest hominoids, is more derived postcranially than pencontemporaneous and younger taxa. Moreover, to date, *Morotopithecus* is found only in northeastern Uganda, not at the younger Napak sites to the south, or at any of the Kenyan early Miocene sites in the eastern rift. It has also seemed unexpected that the carbon isotopic dietary signatures obtained from the enamel from a range of herbivore guilds at Moroto are considerably more positive than those found in modern closed-canopy forest-dwellers, and instead suggest a fragmentary forest or woodland habitat.

Our combined data suggest an explanation for these incongruities: *Morotopithecus* may have evolved its more versatile postcranium to better exploit leaves arboreally at large body size in an environment in which it became necessary to traverse gaps in a broken canopy. This perspective contrasts with the long-held view that exploitation of ripe fruit selected for hominoid postcranial apomorphies.

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**Shuar Health and Life History Project: Varieties of collaborative research and the translation of scientific research in Amazonian Ecuador**

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In human biology, the translation and dissemination of health information to study participants is an essential component of conducting health research. However, at multiple levels, local and investigator interests, constraints, and resources shape how results are presented as well as determine the kinds of local collaborations possible. These issues are perhaps most acute when working with indigenous communities whose access to education, and exposure to researchers, medical personnel, and/or health training/knowledge may be limited. Furthermore, researchers must find relevant and meaningful frameworks for participants to understand their own health status, a process that requires understanding participant perspectives and knowledge, and situating their results within the context of other members of their population as well as other reference populations. Here, we discuss examples of collaborations with Shuar forager-horticulturalists of Amazonian Ecuador, forged over nine years of research. We highlight the importance of understanding local meanings of “collaboration” and the value of negotiating the types of collaboration that are meaningful to individual communities. Additionally, we discuss the importance of providing immediate individualized results and of developing follow-up education sessions summarizing health results more broadly. Our experience conducting research over the past decade stresses the effectiveness of creating opportunities that empower participants and communities to make informed decisions about their health by providing access to the relevant knowledge within the context of resources reasonably available to them.

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**Osteonal repathing: A broader context for the interpretation of type II osteons and bone remodeling vasculature across development**

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Understanding bone histomorphometry has been useful in anthropology for estimating age and physical activity, identifying species and disease, and tracking taphonomy and diagenesis. This is true despite considerable variability in regional microstructure across development and between sexes. For example, histologists have long recognized that small secondary osteons can appear within the boundaries of a previously existing osteon. Evidenced by an internal reversal line, these ‘Type II’ osteons have been attributed most often to maintenance of mineral homeostasis and seem to increase in frequency with age. However, current 3D histological techniques reveal Haversian systems are more complex networks than previously realized. In

addition, careful observation of 2D fragment orientation indicates generations worth of fragments have associations with the most recent osteons. This suggests existing osteonal vessel systems can simply be reused. This type of repathing activation begins along a vessel canal rather than branching off from it and can remain internal with respect to the original system’s cement line (creating a type II osteon). Alternately it can resorb past that cement line in one or more directions to turn over adjacent primary or secondary tissues without the need for metabolically expensive angiogenesis and without resulting in the generation of new canals, a previously undescribed phenomenon. Combined 2D and 3D perspectives like this one shift the attention from remodeled bone to its dynamic vascular system and result in new testable hypotheses. Implications for histological age estimation and the study of osteopaenia also warrant future attention.

**Synchrotronic three-dimensional reconstruction of cortical bone for analysis of osteonal branching and interconnectivity across age**

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This study used synchrotron high resolution micro-CT scanning to reconstruct three-dimensional osteonal networks in cortical bone and analyze their interconnectivity across age. Secondary osteons result from bone remodeling processes, accomplished by Bone Multicellular Units, the coordinated activity of osteoclasts and osteoblasts. Most of our knowledge about osteonal networks derives from two-dimensional microscopy, which is limited in its ability to reveal their complex nature. For this reason, the present study reconstructed three-dimensional osteonal networks (2.925 mm<sup>3</sup> volumes of interest) of six male femoral samples (20-71 years) from the anterior cortex. Since remodeling continues throughout life, we hypothesized that osteonal networks should show significant age differences in the frequency of branching events (acutely-angled branches) and Volkmann’s connections (transversely-oriented) per osteon. Results revealed great variation in branching events, in most cases connected to ‘repathing’ (a younger osteon growing inside an older osteon). In general, Volkmann’s connections were most frequent with individuals sometimes showing a preference for transverse versus slightly sloped canals. Despite age trends in connection types, the total number of connections was similar across all ages. Osteons had an average number of branching events ranging at 1.6-2.7 within the reconstructed volume. Volkmann’s canals tended to become less frequent with age while the opposite was the case for branching and repathing events. Contrary to expectations that



fragments are avascular, we also frequently observed fragments with canals, connected to more recent osteons by Volkmann's tunnels. Future research will address these and other complex interconnections in more detail.

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**Social weaning: childhood diet and health in medieval Canterbury, UK**

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Food consumption during the medieval period is understood mainly from adult diet, higher status families, and monastic communities. By contrast, there is little direct evidence for foods consumed by children, or whether their diet corresponded with health and status. Here, we address these questions in skeletal samples from the medieval city of Canterbury. We undertake the first comprehensive intra-specific microwear texture analysis of childhood diet ( $n=51$ ) and integrate this with histological 'snap-shots' of general health from enamel accentuated markings ( $n=71$ ). An adult comparative sample ( $n=11$ ) is included.

Microwear texture complexity values increased from age 1 to 4yrs while anisotropy values decreased suggesting that foods became harder and required more varied jaw movements during chewing. The 4.1-6 year olds had a significantly lower mean complexity value than younger children. Complexity values increased again while anisotropy decreased in 6.1-9 year olds. Prevalence of accentuated markings peaked at 6 months, early in the second year, and just before age 4yrs. Diet did not relate to childhood status, and adults consumed a greater range of softer and harder foods.

Health of the youngest children likely relates to an immature immune system. Correspondence between a softer diet and improved health around age 4yrs may indicate the start of 'social weaning'. Textual evidence refers to lifestyle changes from this age onwards, as children undertook household chores and then work outside the home. This might have provided less opportunity for early childhood dietary staples contaminated with grit, and initially introduced a softer but more nutritious adult food.

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**Potential caveats in body mass estimation: comparison of reported living and measured cadaver weight**

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Body mass estimation from skeletal remains is rarely used in forensic anthropology, but modern skeletal collections with associated body mass information could be used for testing and creating body mass estimation methods. This poster will discuss potential problems in documented weights associated with skeletal samples.

This research compares the reported living and measured cadaver weights associated with the W. M. Bass Donated Skeletal collection at the University of Tennessee. A large proportion of the donations has a reported living weight in their file, and since 2012 the Forensic Anthropology Center has weighed the incoming cadavers. However, there are many factors that can affect both of these weights. Reported weights are known to be underestimates, and weight can fluctuate during life due to several factors. Also cadaver weight is influenced by other factors, such as time since death at the time of weighing and possible illnesses.

Documented information for 189 individuals with both cadaver and living weight were used in this study. The average difference between the reported living and measured cadaver weight was 12.7 kg. The reported weight was more often bigger than the cadaver weight, indicating weight loss later in life. The weight differences varied from -78 kg to 55 kg. The preliminary results show that the time since reporting the weight has the greatest impact on the difference between reported and cadaver weight. Other variables such as age, time since death when weighing, and medical history are less important factors in this sample.

**Nail-like distal phalanges on postaxial digits is related to use of a terminal branch niche in non-primate mammals**

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The importance of nails for locomotion in a terminal branch niche by primates has been questioned with the observation that some sciurid

rodents and various marsupials retain claws but negotiate this habitat effectively. This observation presumes that substrate- or grasping-type-correlated variation in distal phalanx morphology among non-primates is negligible.

We explore this assumption by comparing pedal grasping in non-primates (16 species, 6 of which are described to inhabit a fine branch niche) to extant primates (4 non-leaping arborealists, 12 vertical clinger and leapers, 15 generalized arborealists, 6 tegula-bearing species), claw-climbing non-primates (11), and the fossil *Notharctus tenebrosus* (AMNH 143612/143640).

Canonical variates analysis (CVA) of geometric mean-adjusted measurements from elements of pedal rays 1 and 3 or 4 separates extant primate groups (100% of original cases and 84.4% cross validated correctly classified) and classifies *Notharctus* as a vertical clinger and leaper (probability 0.9996). Of the non-primates, *Tarsipes rostratus* (honey possum) falls within nail-bearing primate morphospace.

CVA of 15 size-adjusted non-hallucal distal phalanx measurements reveals a morphocline from claw-climbing non-primates to pedal-grasping non-primates to extant nail-bearing primates. Both *Notharctus* and several small branch specialists fall between non-primates and primates. *Tarsipes* falls within the nail-bearing morphospace.

In contrast to previous claims, we conclude that there is a functional link between features associated with primate-like grasping and terminal branch locomotion that is generally applicable to other mammalian groups. Therefore, the hypothesis that a shift to a terminal branch niche has affected the form of primate distal phalanges becomes more likely.

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**Studying the evolutionary history of Native North Americans**

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Current and past transgressions of anthropological researchers studying Native Americans have created an environment of uncertainty and mistrust of researchers in indigenous communities. This cynical environment has contributed to a dearth of DNA information from key geographic regions in North America and also a lack of expertise of genomic knowledge among Native American



community members. These factors have limited the ability to use DNA variation to infer evolutionary history of Native Americans and have also limited any potential health benefits Native Americans may receive from studies in genomic medicine. To change this environment we have created protocols to help establish trust and create mutually beneficial collaborations between researchers and Native Americans. In addition, we organize a training program to facilitate discussion and learning of genomics for Native American students and community members. Details of our collaborations with First Nation communities in British Columbia and also the SING (Summer Internship for Native Americans in Genomics) Program are discussed.

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#### Use of high-throughput sequencing to investigate white-faced capuchin prey choice

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Which food resources primates choose to exploit is dependent on a number of changing social and ecological factors, including nutrient balancing, food availability and distribution, patch size and quality, and the presence of conspecifics. In faunivorous primates, such as capuchin monkeys, previous field studies have been limited by an inability to accurately determine what taxa of animal prey are being consumed, decreasing the researchers' abilities to assess the nutrient content of all components of the diet, the influence of variation in animal prey availability, age- and sex-based differences in prey choice, and how prey choice relates to the microhabitats in which primates forage. In this study, we use high-throughput sequencing of invertebrate mtDNA from the feces of white-faced capuchins (*Cebus capucinus*) to determine patterns of animal prey consumption over a yearlong study. From January 2013 through January 2014, 235 fecal samples were collected from adult female, adult male, and juvenile white-faced capuchins at La Suerte Biological Field Station in northeastern Costa Rica. DNA was extracted from fecal samples. A ~300bp fragment of the COI mtDNA was amplified using universal primers for invertebrates. Samples were individually barcoded and sequenced on the Illumina MiSeq platform. Sequences were clustered into operational taxonomic units (OTUs) and OTUs were compared to known COI sequences in GenBank and the Barcode of Life Database. Preliminary analyses of 54 fecal samples have identified 11 Orders, 23 Families, 22 Genera and 18 species of arthropods, greatly increasing our knowledge of the diversity of invertebrates in white-faced capuchin diets.

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#### Weaning and hominoid life history: Serial isotopic sampling of *Pan troglodytes* tracks dietary change across development

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Assessing the timing and pace of weaning in extant apes may be the key to characterizing the life histories of members of the hominoid lineage, even as far back as the early Miocene.

Stable carbon and oxygen isotope analysis of sequentially forming layers of enamel apatite allows direct testing for the pace of dietary changes taking place over developmental time. This study represents the first time an extant ape's enamel has been sampled serially to determine the range of carbon and oxygen isotope values within an individual's dentition over the course of its dental development, from exclusive nursing, to transitional diet, to the fully adult diet.

To develop this baseline of intra-individual isotopic changes during development, we sampled enamel from P<sup>3</sup>-M<sup>3</sup> of a female chimpanzee from Bwindi, Uganda. 4-6 samples were extracted from each tooth from the earliest forming to latest forming crown layers.  $\delta^{13}\text{C}$  values ranged from -16.7‰ to -14.0‰ and  $\delta^{18}\text{O}$  values from the same samples ranged from -0.5‰ to 1.4‰. The carbon and oxygen isotopic values of the last forming layers of enamel continued to increase suggesting this individual had not yet attained a fully adult diet by M<sup>3</sup> crown completion. Comparisons with additional individuals and different modern primate taxa that wean earlier will permit characterizations of intra- and inter-tooth patterns of dietary change. These data will provide a basis for interpreting variable diet patterns throughout the development of an individual, including the nature and timing of weaning, and therefore overall life history patterns in fossil hominoids.

#### Autosomal Admixture in Natural and Anthropogenic Hybrids of Two Species of Eastern Brazilian Marmosets (*Callithrix jacchus* and *C. penicillata*)

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While primate hybridization is documented in taxa that include lemurs, apes, and monkeys, conservation priorities and evolutionary outcomes differ between natural and anthropogenic hybridization. Further, natural and anthropogenic hybridization contexts are sometimes hard to distinguish for primates, which carries important conservation implications for an order possessing many endangered taxa. However, *Callithrix* marmosets can give us a unique look into hybridization under separate natural and anthropogenic conditions. Here, we present results from a study utilizing 42 autosomal microsatellites to describe genotypic admixture in two *C. jacchus* and *C. penicillata* hybrid zones, one at a natural species border along the São Francisco River in NE Brazil and one where the species are exotic to Rio de Janeiro state. Additionally, we describe autosomal genetic diversity for the first time in wild *C. penicillata* and build on existing *C. jacchus* genetic data. Admixture levels and ancestry within the natural hybrid zone were bimodal, i.e. biased toward one species or the other. We also show that fluvial islands in this zone are gateways for bidirectional gene flow across the species border. In the anthropogenic zone, we show evidence of hybrid swarms with intermediate levels of admixture, likely due to an absence of a strong physical barrier to interspecific breeding. Our data suggest that the presence of physical, even if somewhat leaky, barriers help maintain genetic integrity of hybridizing species. Further, the study of hybridization under different contexts will facilitate well informed conservation guidelines for hybrid populations that often fit between "natural" and "man-made."

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#### 'Readmitted under urgent circumstance': uniting archives and bioarchaeology at the Royal London Hospital

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Bioarchaeological study of historical groups may be aided by the use of written records. Fracture prevalence at the Royal London Hospital in London, UK during the late eighteenth and early nineteenth centuries was assessed using skeletal and archival data. These two datasets contribute to an understanding of medical treatment at the

Royal London Hospital; however, uniting these disparate sources of data revealed contradictory fracture prevalence results. Admission and discharge records for the hospital are extant for 1760, 1791, 1792, and the latter half of 1805. Of a total of 3707 adult hospital admissions, 370 were diagnostically labeled as fracture. The skeletal remains of 123 adult individuals buried at the Royal London Hospital during the early nineteenth century (curated by the Museum of London) were analyzed and 63 individuals were determined to have suffered one or more fractures. A comparison of fracture by body area (dictated by the diagnostic labels used in the archival admission records) revealed statistically significant differences ( $p < 0.01$ ) in the fracture prevalence between the archival and skeletal results for the leg, rib, foot, hand, nose, spine, wrist, ankle, and hip areas. These results highlight the contradictions that may be encountered when incorporating multiple lines of evidence; disparate datasets may provide differing pictures of what constitutes a 'normal' or 'expected' rate of fracture in a particular group. In addition, this paper raises biocultural questions concerning individuals' lived trauma experience and choice to seek medical treatment for certain types of fractures.

#### **Sex and age comparisons of chimpanzee grips during feeding in Mahale Mountains National Park, Tanzania**

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The manipulative abilities of chimpanzee and human may shed light on the evolution of the human hand. Until recently most of what we knew about chimpanzee manipulation came from captive apes. Marchant et al. (2014) provided an analysis of grips by wild chimpanzees in the Mahale Mountains National Park, Tanzania. That study analyzed patterns of food retrieval and processing from videotapes of chimpanzees. Here we provide results on the relative use of specific grips by males and females and how age impacted the grip types used. Two hundred sixty-six female and 159 male grips were analyzed. The sexes were highly correlated in the relative frequencies of grips used ( $r = 0.97$ ). Males and females used the 2JCPS (2 jaw chuck pad-to-side) for more than 50% of ant fishing, elephant grass, small fruits and vines. Sex differences emerged for grips used on two objects: males used the 2JCPS grip in 100% of cases involving bone, compared with 50% in females; carcasses were processed with the ETH grip (extended transverse hook) in 81% of cases by males while females used it only 47%. Both older infants (2-5 years) and juveniles used all grips with more than 1% frequency in the earlier study. Juveniles

manipulated all the same objects as adults except vines; the older infants were not seen to manipulate elephant grass, bones or branches. We discuss the significance of sex differences in carcass processing and the ontogeny of grip use in wild chimpanzees.

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#### **Hunting for pathogens: ancient DNA and the historical record**

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Ancient DNA is an increasingly significant line of evidence in the paleopathological toolkit; yet, when samples are from contexts where no known epidemics or plagues are recorded in the historical record, the identification of potential pathogens raises methodological challenges. To address this, a strategy of directly shotgun sequencing samples to identify the metagenome (e.g., all organisms) was implemented, complemented by evidence from ancient literary and archaeological sources. DNA isolated from the dental samples of 57 individuals (1<sup>st</sup> to 3<sup>rd</sup> c. A.D., Italy) enabled a species-level characterization of the human microbiome with its range of commensal, pathogenic and symbiotic microorganisms. The microbial profiles indicate very low levels of genera containing potential human pathogens (0.001-0.08%). Conversely, environmental and microbiomic taxa characterize the majority of the sample constituents (e.g., *Actinomycetales*, *Coriobacteriales*, *Bacteriodales*, *Bacillales*, *Clostridiales*). A preliminary evaluation of this dataset relied on a stringent analytical approach to authenticate the species-specificity of the genomic data in order to identify disease-associated pathogens as candidates for targeted enrichment coupled with high-throughput sequencing. This analysis is also situated within an interpretive framework drawn from descriptions of causation and symptomology in written texts and the physical environment as it relates to disease ecology (e.g., palaeoenvironmental evidence). Within this multifaceted approach to retrospective diagnoses, a critical question remains – how much analytical weight can be assigned to preliminary genomic data when the presence (or absence) of a particular pathogen is indicated?

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#### **Homogeneity of Tetracycline Labeling Across Classes in Early Christian Burials from Kulubnarti, Nubia**

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Tetracycline labeling is present in human remains from the Medieval Sudanese-Nubian site of Kulubnarti. A hypothesized conduit for *in vivo* consumption of this antibiotic is beer contaminated with *Streptomyces* bacteria. This bacterium is highly prevalent in Sudanese-Nubian soil (60-70%) and secretes tetracycline under harsh conditions such as fermentation. The mud bins in which ancient Nubians stored their grain would have provided the warm, alkaline environment necessary for *Streptomyces* to flourish.

At Kulubnarti, two early Christian communities are represented in contemporaneous S (716 CE) and R (752 CE) cemeteries. Archaeological and osteological evidence supports interpretations that the latter cemetery group was a village of freehold farmers; the former, a shantytown of landless itinerants most likely working for the farming community. All indicators of disease and generalized stress have demonstrated poorer health and higher infant mortality in the itinerant community.

Using image analysis software, 38 thin sections of rib bone under ultra violet light were measured for percentages of total labeled bone, labeled osteons, and grid intersections over labeled bone. No significant differences in the amounts of tetracycline-labeled bone were found between the communities at the 95% confidence interval ( $p < 0.05$ ) using Mann-Whitney U tests. Thus, tetracycline was apparently ingested by the S and R communities at equal frequencies. From these results, we surmise class differences were not mediating tetracycline ingestion and both communities had equal access to beer.

#### **The precarious state of subsistence: reevaluating dental pathological lesions associated with agricultural and hunter-gatherer lifeways**

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Numerous bioarchaeological studies emphasize an increase in dental lesions associated with the transition to agricultural subsistence. Unfortunately, this diachronic trend has led to the conflation and oversimplification of specific dental pathologies with specific subsistence strategies. This meta-study builds upon the initial work of Christy Turner II, with recent data from

140 archaeological sites peer-reviewed anthropology publications, on the distribution of dental pathologies (caries, antemortem tooth loss, abscesses, and linear enamel hypoplasia) among classified agricultural and hunter-gatherer subsistence groups. Subsistence (agricultural versus hunter-gatherer) and climatic (temperature variation, altitude, and precipitation) variables are tested as possible predictors of dental lesion variability. Despite significant differences in the average prevalence of caries between agricultural and hunter-gatherer populations, the variation in caries prevalence shows high (50%) overlap between the subsistence patterns. Additionally, differences in the prevalence of antemortem tooth loss, abscesses, and linear enamel hypoplasia among agricultural and hunter-gatherer populations are not significant and also show demonstrative overlaps in confidence interval ranges. Although climate is not a unilinear predictor of dental lesions, results indicate that individual climatic factors are significantly correlated with the prevalence of antemortem tooth loss and linear enamel hypoplasia among agricultural and hunter-gatherer populations. These results emphasize the need for a reevaluation of specific dental pathologies as pathognomonic indicators of broad subsistence patterns. In conclusion, our results call attention to the complicated, multifactorial pathogenesis of dental lesions and highlight the non-linear relationship between dental pathologies and specific biocultural environments.

**Physical Anthropology in the Renaissance as revealed by the medical writings of the Portuguese physician Amatus Lusitanus (1511-1568)**

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The German Johann Friedrich Blumenbach (1752-1840) is often credited for the birth of physical anthropology (PA). Throughout the scientific revolution that took place during the Enlightenment the interest on human biological variation was already noticeable, namely through the works of naturalists such as Carolus Linnaeus (1707-1778), Georges-Louis Leclerc or Comte de Buffon (1707-1788), and Petrus Camper (1722-1789). However, the progress on the study of human anatomy attained during the Renaissance and its link with the genesis of PA cannot be overlooked. During this period the practice of human dissections and anatomical treatises opened the door to the scientific study of human tissues and organs, including the skeletal system. Nevertheless, little is known to what extent the early anatomists made use of human bones to investigate specific anthropological problems. This study aims to discuss how the Renaissance medical texts can serve as a source for the history of PA. We analyze one of the earliest evidences of the

practice of PA by the Portuguese Amatus Lusitanus (1511-1568), pseudonym of João Rodrigues. During the 16<sup>th</sup> century, this physician published 7 volumes entitled *Curatationum medicinalium centuriae*, each containing 100 cures (*curas*) reporting unusual medical cases treated in several European countries. On the 4<sup>th</sup> *centuriae* Amatus reports his attempt to understand handedness by measuring the weight differences between left and right humeri. These descriptions provide new clues regarding the early practice of PA and show the importance of Renaissance medical writings for the history of this discipline.

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**A Middle Woodland Co-mingled Burial with Evidence of Rickets**

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Monkey Mountain (23J014) is a late Middle Woodland site outside of Warrensburg, Missouri, at which human remains were discovered inside a stone crypt. This type of burial mound supports a cultural connection to similar burials in the Kansas City area, 50 miles to the west. The site was excavated in the 1960's and 1970's by local interested professors and has since been curated at the University of Central Missouri Museum and Archives. The fragmentary remains consist of 5 individuals, including an infant (1 year old), a juvenile (5-6 years old), and 3 adults (30's), a similar multi-age burial to other stone crypts. There is evidence of secondary burial based on the wide range of weathering stages; the best preserved bone was located adjacent to or within the crypt wall, the stone of which appeared to balance the acidic soil. The adults are skeletally robust and free of osteophytic activity. Several of the adult long bones present abnormal shapes: a left femur with anteroposterior compression and a triangular cross-section with consequent medial and lateral ridges; left tibia with lateral bowing and mediolateral compression; right tibia with slight mediolateral compression; and fibula with thick cross-sectional area and large interosseous ridge. The tibia may be evidence of a vitamin D deficiency, resulting in childhood rickets. No evidence of femoral genu varum has been observed. This work extends the known range of a local culture and shows evidence of an individual who survived childhood rickets.

**Tropical research is biased towards national parks containing great apes**

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Researchers have long contributed to conservation of tropical biodiversity at their field sites, but we know little about where they focus their efforts and why they choose to work in some areas over others. We used Google Scholar to assess research activity for all terrestrial protected areas in 23 African and Asian countries and found that researchers are 2.6 (95% CI 1.38–3.91,  $P < 0.001$ ) times more likely to publish work concerning protected areas with great apes than concerning those that lack them; the presence of gorillas has a much stronger effect than the presence of other apes. In addition, researchers are 12.5 (95% CI 11.3–13.8,  $P < 0.001$ ) times more likely to publish work concerning national parks than protected areas with other classifications, while larger protected areas also attract significantly more research attention. Our results demonstrate that the presence of researchers and any conservation benefits that they might bring are biased towards large national parks containing charismatic species such as great apes. This suggests that the majority of scientific research in tropical protected areas is focused on areas that are likely to be in relatively good condition, thereby providing an unrealistically optimistic perspective on the status of tropical biodiversity and resulting in crucial knowledge gaps in our understanding of less intensively managed protected areas.

**Investigating Economic Specialization on the Central Peruvian Coast: A Reconstruction of Late Intermediate Period Ychsma Diet Using Stable Carbon and Nitrogen Isotopes**

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This project uses stable carbon and nitrogen isotopes in archaeological human bone collagen to test a classic ethnohistoric model that proposes Central Andean coastal polities were comprised of multiple economic specialist communities. Specifically, we focus on the Ychsma polity (c. AD 900-1470) of the Rimac and Lurín Valleys on the central Peruvian coast. This region subsequently became the location of key Inca ceremonial and administrative centers and later the capital city of the Spanish Vice Royalty.



Understanding the nature and impact of the Inca conquest and Spanish colonization requires empirical investigations of Ychsma social organization and interactions prior to these sociopolitical transformations. Previous emphasis on ethnohistoric data to understand Ychsma social organization has led to a generalized representation of Ychsma communities as internally homogenous and territorially bounded according to subsistence specialization. We used stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope analysis of archaeological human bone collagen to reconstruct the diets of 40% of individuals recovered from burials at Armatambo ( $n=67/168$ ), associated ethnohistorically with a fishing specialist community and at Rinconada Alta ( $n=46/111$ ), associated ethnohistorically with an agricultural specialist community. Individuals buried at Armatambo exhibit significantly increased mean stable nitrogen isotope ratios, suggesting these individuals consumed relatively greater quantities of marine resources. Variation within large-scale trends, however, suggests sub-group specialization and/or fluidity between groups.

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#### **Ontogeny of nasal turbinals in *Lemur catta***

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This study investigates development of the nasal turbinals in *Lemur catta* from the fetal to adult stages. The great number of turbinals in strepsirrhines is assumed to correlate with a strong olfactory sense, but recent work indicates some morphological variations exist among lemurs and lorises. The developmental basis and functional implications of this variation have not been explored.

Using CT scans and histology of five different *Lemur catta* at different ages, we were able to observe the order in which the turbinals develop. Six large "endoturbinals" are present: four ethmoturbinals, one nasoturbinale, and one maxilloturbinale. Four smaller turbinals are found in the frontal recess. Histology of neonates reveals that most elements are present at birth, except that only three turbinals are present in the frontal recess. The sequence of ossification starts *in utero* with the nasoturbinale, maxilloturbinale, and the first ethmoturbinale. Posterior to these turbinals, ethmoturbinals II through IV, as well as the frontoturbinals, are ossifying by about one month postnatally. Through these observations,

we are able to demonstrate that the nasal turbinals in *Lemur catta* develop from anterior to posterior. Furthermore, since the majority of the ethmoturbinals and the frontoturbinals ossify later in infancy, it can be surmised that they are expanding in size postnatally via cartilaginous growth. These observations imply that some olfactory surfaces are less extensive in newborns and instead expand gradually as the posterior ethmoturbinals grow. Accordingly, olfactory reliance may increase postnatally as surface area expands.

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#### **Maternal Resources, Brain Development and the Pelvic Constraint**

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*Average* adult relative brain size is higher in primates than in other mammals, but considerable overlap exists. Although human relative brain size is largest, dolphins have the next largest values. Nevertheless, throughout fetal development, and hence as neonates, primates have relatively larger brains than all other mammals. This distinctive feature highlights the importance of gestation for brain development. Along with similar scaling of brain size and basal metabolic rate, this suggests a link with maternal energy turnover. Starting from a negative correlation between brain and gut size in primates, the alternative "Expensive Tissue Hypothesis" infers that a trade-off operates. But analysis of a large dataset for mammals revealed no significant relationship between brain and gut size after eliminating confounding factors. By contrast, analyses allowing for confounders supported the competing Maternal Energy Hypothesis. Human brain development shows several unique features. Neonates are relatively large with correspondingly large brains, yet the brain quadruples in size after birth rather than doubling as in other primates. Nevertheless the human brain is so big at birth that it poses an "obstetric dilemma": The fetal head only just passes through the pelvic canal after complex rotation. In a recent challenge, it was proposed that the primary constraint is posed by maternal energy costs reaching a maximal level by birth. But "genetic pruning" clearly selects against overlarge neonatal heads and undersized pelvic canals. The pelvic constraint in human birth is highlighted by the lack of any constraint on birth of large-brained neonates in pelvis-less dolphins.

#### **Sexual dimorphism and male-male competition in blond capuchin monkey in Atlantic Forest of Brazil**

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Texas at Austin, <sup>2</sup>National Center for Research and Conservation of Brazilian Primates, Chico Mendes Institute for Biodiversity Conservation.

Sexual selection is argued to play an important role in the evolution of sexual dimorphism (SD). Blond capuchin monkeys (*Sapajus flavius*), endemic to the Atlantic Forest of northeastern Brazil, are medium-sized New World primates that live in multimale-multifemale groups whose size varies between 9 and 90 individuals. Over a four-year period, we captured and measured wild blond capuchins in two areas of Paraíba State, Brazil. Body weight and morphometric data were recorded from 16 adult males and 14 adult females. Males were significantly larger and had longer canines than females (one-tailed Mann-Whitney tests:  $p < 0.0001$ ). We also calculated the ratio of male-to-female body size and canine length to characterize the degree of SD in these features. In both measures, *S. flavius* was among the more dimorphic genera of platyrrhines. Finally, we examined the relationship between testes size and body weight in a comparative sample across primates to evaluate the degree of sperm competition in this species. *S. flavius*' relative testes weight was intermediate between the averages for males in unimale versus multimale mating systems, and within the range of variation in both. The relatively high level of body and canine size dimorphism found in our analyses contradicts behavioral data suggesting low levels of within-group aggression and a high degree of tolerance among males in wild blond capuchins, which raises the possibility that other factors besides intragroup mating competition (e.g., intergroup competition and female mate choice) may have shaped patterns of sexual dimorphism in this species.

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#### **Dental remains from the Sima de los Huesos**

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To date, the Sima de los Huesos dental sample consists of more than 530 permanent teeth including all dental classes and assigned to a minimum number of 28 individuals. This sample has been characterized with classic morphometrics, geometric morphometrics and also recently, by means of microtomography. These studies are consistent in the identification of strong Neanderthal affinities. The SH dental remains present all the features that either in their degree of expression, frequency and/or pattern of combination have been considered typical of *H. neanderthalensis*. However, the SH dentitions do not fit in a progressive "neanderthalization" sequence as they are i) more derived than some contemporaneous populations such as Arago and



Mauer and ii) "more Neanderthal than some Neanderthals" themselves, by falling in the extreme of the gradient of the Neanderthal variation for some features. In addition, the SH dentitions present some unusual features for a Middle Pleistocene population such as posterior teeth that are smaller in absolute terms than those of other Pleistocene groups, and are comparable to modern humans not only in size but in other traits such as similar intermolar size ratios, frequent absence of hypoconulid and hypocone and pattern of cusp proportions in upper first molars. This line of evidence is not in favor of a gradual or anagenetic process for the evolution of the European Middle Pleistocene groups. Here, we reevaluate the taxonomic and phylogenetic position of the SH population and question its allocation into a taxon (*H. heidelbergensis*) that has Mauer as its holotype.

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#### **Microindentation testing of olive colobus mandibles suggests role for phylogenetic affinity in determination of mandibular bone material properties**

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Material properties of the mandibular bone in two colobine and two cercopithecine monkeys ranging in Côte d'Ivoire's Taï Forest have been investigated and interpreted in relation to diet. However, olive colobus (*Procolobus verus*) mandibles have not been studied to date. Consuming a relatively soft diet with an emphasis on young leaves, *Procolobus verus* foods are less mechanically challenging than those selected by sympatric colobines and one cercopithecine (*Cercocebus atys*) but are thought to be similar to those preferred by the diana guenons (*Cercopithecus diana*) in being neither tough nor hard. The olive colobus thus provides a test case for whether mandibular stiffness variation tracks functional demands (diet) or phylogenetic affinity.

In this study, we examine bone stiffness in the postcanine corpus of four adult olive colobus operating under the null hypothesis of no interspecific difference. Vickers microindentation was performed on rehydrated coronal sections taken between M<sub>1</sub> and M<sub>3</sub>. Hardness values were converted to elastic modulus by established regression. Elastic modulus was then compared among the colobines and cercopithecines. *Procolobus verus* mandibular bone is not significantly different from that of *Colobus polykomos* or *Procolobus*

*badius*; however, as a group, these colobines have significantly more compliant bone than does *Cercocebus atys*. Three of the four *Procolobus verus* mandibles have average stiffness values below those of *Cercopithecus diana*. These data provide additional evidence that colobines have less stiff mandibular bone than cercopithecines irrespective of diet.

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#### **Investigating the Genetic Effects of Spanish Colonialism: A Comparison of Ancient and Modern Mitochondrial DNA from Xaltocan, Mexico**

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Spanish colonialism had profound genetic effects on native populations in central Mexico. Previous studies have shown that gene flow from Spanish colonists and African slaves introduced new genetic variants into indigenous populations, but the magnitude of this genetic impact likely varied across communities. While Spanish colonists interacted extensively with some indigenous communities, other communities had much less direct contact. Spanish colonists also reorganized many native communities into *congregaciones*, altering patterns of indigenous gene flow.

We investigated the genetic effects of Spanish colonialism on Xaltocan, a community in central Mexico. Although archaeological evidence indicates that some indigenous residents adopted Spanish material culture, colonial documents describe Xaltocan as a *pueblo de indios* ("Indians' town") that was rarely visited by Spaniards. Because Xaltocan was the location of a *congregación*, Spanish colonialism might have also increased gene flow from other native populations. For this study, we compared patterns of genetic diversity in residents of pre-Hispanic (n=38) and modern (n=42) Xaltocan by sequencing the first hypervariable region of the mitochondrial genome and determining mitochondrial DNA (mtDNA) haplogroups and haplotypes.

We found that all pre-Hispanic and modern samples belonged to the founding Native American mtDNA haplogroups, indicating that Spanish women made little contribution to the Xaltocan gene pool during the colonial period. We also found that pre-Hispanic and modern Xaltocan differ significantly in their mtDNA haplotype composition. This finding suggests that gene flow from other native populations

played an important role in reshaping the genetic composition of Xaltocan during the colonial period.

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#### **Using Manual Phalangeal Curvature to Explore Locomotion in Extinct Hominoids**

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The manual phalanges of primates are highly affected by the loads imposed upon them during locomotion. Proximal phalangeal curvature has been used to infer suspensory or non-suspensory locomotion in primates, but finer discrimination can be made when middle and proximal phalanges are considered together. Indices comparing the curvature values of middle and proximal phalanges within digits 2-5 (the Indices of Relative Curvature) were shown to be successful at differentiating between knuckle walkers, quadrupeds, suspensory primates, and humans. This locomotor signal retains its strength even when the indices are calculated from middle and proximal phalanges of different rays from the same hand *and* when the indices are composed of elements from *different individuals* within the same species. This suggests that Indices of Relative Curvature can be applied successfully to fossil hominoids for which digit identity cannot be accurately determined, and for which isolated proximal and middle phalanges may not belong to a single digit or single individual. The present study uses phalangeal curvature indices to explore locomotor capabilities in selected fossil hominoids. The results are consistent with previously published research for the Miocene apes: *Hispanopithecus* has highly curved phalanges similar to those of the suspensory primates, while digits of *Proconsul*, *Pierolapithecus*, and *Sivapithecus* suggest a more quadrupedal mode of locomotion. Results for the included hominin are also consistent with previous research: *A. afarensis* has index values similar to those of knuckle walkers (slight curvature in the proximal phalanx coupled with straighter middle phalanges) which is consistent with climbing.

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### The Application of 3D Digital Microscopy in Identifying Evidence of Human Butchery of Extant Lemurs

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Faunal remains at archaeological sites can be used to address direct anthropogenic impacts on ecosystems. However, due to the late arrival of modern humans to Madagascar the decline of megafauna on the island, particularly of giant lemurs, remains under debate. Currently, direct evidence of human skeletal modifications and hunting of megafauna is limited. In addition, methods previously used to address the extent of post mortem processing of megafauna, including cut mark morphology, are time-consuming, introduce unwanted measurement errors, and are prohibitively expensive for large samples. However, 3D digital microscopy can address these limitations and provide detailed morphometric analysis (e.g. depth, width, and length) of potential bone modifications associated with human butchery. In this poster, we test the use of 3D digital microscopy using a Keyence 3D digital Microscope VHX-2000E to analyze bone modifications on epoxy resin positive casts of femora and humeri from *Pachylemur*, *Palaeopropithecus*, and *Archaeolemur* from four paleontological sites in Southwest Madagascar including Ampasambazimba, Beloha Anavoaha, Tsirave, and Manombo Toliara. Preliminary results of our analysis show an overall improvement (<1mm) in morphometric data of cut marks compared to previous methods and lends archaeological support to the role of human hunting in Malagasy megafaunal decline. In addition, frequencies of modification in this study average 1-3% at Ampasambazimba, Beloha Anavoaha, and Manombo Toliara, and 13% at Tsirave suggest potential site bias. Future work will address this bias and use 3D microscopic image stitching to identify tool class and usage patterns in megafaunal butchery.

### Evolution of the hominin scapula and rotator cuff musculature

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The morphology of the shoulder girdle not only plays an important role in the discussion of the locomotor behaviour of early hominins, but it may also be an aetiological factor in degenerative shoulder disorders including rotator cuff disease or shoulder impingement syndrome. Lesions of the rotator cuff (supraspinatus, infraspinatus, subscapularis and teres minor) are common in modern humans, but virtually absent

in great apes even at an advanced age. Humans are reported to have relatively smaller supraspinatus muscle. It has therefore been theorized that shoulder impingement results from overload of the supraspinatus tendon due to dysbalance and weakness of the rotator cuff muscles.

Here, we perform a landmark-based three-dimensional analysis of the scapular morphology in extant great apes (71 *Hylobates lar*; 20 *Pongo* sp.; 39 *Gorilla gorilla*; 44 *Pan troglodytes*), MH2 (*Australopithecus sediba*), a cast of KNM-WT 15000 (*Homo erectus*), and a sample of 89 modern human scapulae. In contrast to previous studies that were based on linear measurements and indices, we find that the supraspinatus fossa and by inference the supraspinatus muscle have the same relative size in all examined species. Also the subacromial space is virtually identical in great apes and humans relative to body size. This challenges common theories about the aetiology of shoulder impingement syndrome. Moreover, our study demonstrates that linear measurements do not acknowledge the complex 3D anatomy of the shoulder girdle.

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### Phenotypic inference from ancient DNA

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One of the most exciting consequences of recent developments in ancient DNA technology is that we have the ability to infer the phenotypes of ancient samples for traits that cannot be reliably inferred from skeletal remains. Important examples include pigmentation traits, dietary traits like lactase persistence and amylase copy number, and disease resistance mutations. These have relatively simple genetic architectures, but by using information from genome-wide association studies, and by genotyping many more sites, we can also predict the values of polygenic traits that are controlled by many loci, for example height, weight, and complex disease

susceptibility. By investigating how they change through time, we can disentangle the effects of natural selection and population turnover in the evolution of these traits.

In this study, we present genetic data from a series of samples from seven archaeologically defined cultures in central Europe, ranging from 8000BCE to present. We have genotyped these samples at 390,000 genomic loci, including 30,000 which have known phenotypic effects. We then use this data to distinguish between traits that have changed consistently with population turnovers, traits that have changed apparently neutrally, and traits that have changed dramatically due to recent natural selection. Finally, we investigate whether we can detect selection in polygenic traits like height or weight.

These data demonstrate a powerful new source of information about ancient samples, and have the potential to teach us both about the specific traits of these populations, and also about the general mechanisms of evolution and adaptation in human history.

### Chest wall tuberculous abscess: a rare and challenging diagnosis on past human skeletal remains

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Diagnosis of pathological conditions in past human remains is a challenging and difficult endeavor, even when biographical records are available, as it is the case of skeletons from reference collections. Establishing a direct causal association between a deadly process and the observable bone changes at the time of death requires both expertise and a careful exercise of differential diagnosis. In order to show how this process is intricate, we present the paleopathological examination of the skeleton 361, a young adult female deceased by pulmonary tuberculosis in 1948, from the Identified Skeletal Collection housed at the Bocale Museum, National History Museum (Lisbon, Portugal). The most striking pathological change consisted on a bony fusion between the 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> left rib shafts with a perforated central area, with 10 mm in diameter, resembling a draining sinus. The differential diagnosis of these lesions reveals that a tuberculous abscess of the ribs is the most probable explanation, with the individual's cause of death supporting this inference. However, ruling out fungal or pyogenic infections, traumatic, neoplastic or congenital conditions, and an iatrogenic cause as possible etiologies is a difficult task in the absence of detailed clinical or autopsy records. This study shows that chest wall tuberculous abscess is virtually undiagnosable on archaeological human remains due to the lack of

specificity of the bone changes. This is a common scenario and paleopathologists should be aware of this bias when ascertaining or debating the past prevalence of diseases.

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**Health and the biological damage hypothesis in the Lambayeque valley: examining the consequences of early life stress in the late pre-Hispanic and Colonial periods**

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This study evaluates two hypotheses that address the biological consequences of Spanish conquest and how indigenous Mochica responded to early life stress using metabolic stress indicators, localized infection, and trauma. The first hypothesis posed that native health outcomes would decline significantly in the postcontact era. Contact inevitably introduced a series of complex cultural, biological, and socioeconomic processes that swept through Northern Peru. The second hypothesis predicts that native Mochica who experienced early life stress would be more susceptible to mortality. In essence, physiological disturbances incurred during early childhood would alter projected developmental pathways to aid the immediate survival of the infant. Consequently, this trade-off would have far-reaching effects on lifespan and the capacity to resist further stress insults. Odds ratios were calculated to determine age-specific prevalence between the Late pre-Hispanic and Colonial periods in the Lambayeque Valley, Peru. Mean age-at-death and life expectancy were calculated for those featuring skeletal stress indicators and compared to those who did not. Surprisingly, precontact Lambayeque exhibited significantly higher prevalence of enamel hypoplasia and porotic hyperostosis. A significant negative relationship existed between presence of skeletal stress markers and reduced age-at-death in the Colonial sample. As a multiplicity of high-mortality epidemics swept through Lambayeque during this era, it was determined that residents of postcontact Lambayeque were living in an altered epidemiological landscape. As such, this phenomenon likely promoted an underestimation of systemic stress and confounded interpretation of the biological damage hypothesis.

**What femoral bone morphometry can tell us about the physical burden of early farmers at the advent of agriculture in the Southern Levant?**

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The Neolithic revolution (10,500 - 4,300 BCE) in the southern Levant was one of the most significant cultural processes in human history. A debated question accompanying the discussion about the impact of agriculture revolution on humans' way of life relates to the changes in the amplitude and pattern of physical stress in early farmers compared to their preceding hunters.

The aim of the study was to reveal the physical stress and activity pattern among the first farming communities in the Levant through the study of the femoral bone cross-sections geometry.

130 femora (30 Natufian, 83 Neolithic and 18 Modern) housed at the anthropological collection, TAU, underwent a high resolution CT scan. Dedicated computer software was developed and utilized to measure 22 parameters of the femoral cross-sectional areas.

Natufians' femoral cortical bone was significantly thicker throughout bone circumference compared to Neolithic and Modern femora. Coefficient of cortical area variation was significantly higher in the Neolithic populations. No significant differences were found in bone rigidity parameters. The Neolithic femoral cross-section shape was more rounded in its mid-shaft compared to the Natufian. In both Natufian and Modern femora, opposed to the Neolithic femora, the cortex was significantly thicker on the lateral side compared to the medial.

To conclude, the significant decrease in bone robusticity with the transition to farming activities reflects a more sedentary way of life in these populations, whereas the greater variability in their bone thickness suggest a more heterogeneous physical activities (division of labor) in early farming communities.

**Migrating Huns and modified heads: Eigenshape analysis comparing crania from Hungary and Georgia**

PETER R. MAYALL and VARSHA PILBROW. Department of Anatomy, University of Melbourne.

Intentionally modified crania in Eastern European burials of the late antiquity period have been attributed to the Huns, nomadic warriors from the Asian steppes, who invaded Europe in the 4<sup>th</sup> century. The mass migration into Europe over the following two centuries included nomadic tribes who practised intentional cranial modification. This practice is found in crania in Western Asia and European burials from that period. They have also been recovered in Samtavro (Southern Georgia) although there is no record of the Huns being in that region. The aim of this study is to explain this anomaly by investigating modified crania from these areas.

Images of twenty-five modified skulls from the Carpathian Basin (Hungary) and twenty-five from Samtavro were taken and the outlines digitalised. An eigenshape analysis was performed followed by discriminant analysis. Thirteen eigenshape variables were used which encompassed 95% of the cranial variation. This revealed a significant difference between the Carpathian Basin and Georgian skulls. Skulls from the Carpathian Basin were dated to the 4<sup>th</sup> - 6<sup>th</sup> centuries whereas examples from Samtavro were also from the 1<sup>st</sup> - 3<sup>rd</sup> centuries, prior to the Hunnic invasion. Even though all the crania had the annular form of modification the Carpathian Basin crania also had significantly less variation than those from Samtavro. This variation is due to the way the bindings are applied and the length of time involved. This uniformity of modification in the Carpathian Basin crania indicates control by a central authority, presumably the Huns. This did not apply to Samtavro.

**Vertebral lesions from a Geriatric sample exhumed from the St. Nicholas Cemetery, Limassol, Cyprus**

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During the 2014 Texas Tech Field School season in Nicosia, Cyprus a geriatric burial sample was analyzed for the presence of skeletal lesions. The sample is comprised of 30 male and female individuals with ages ranging from 60-100 years old. The burials were exhumed from the St. Nicholas cemetery in Limassol, Cyprus and they come with known demographic data specific to sex and age. As one might expect this sample of geriatricians exhibited considerable amount of Osteoarthritis (OA) and Degenerative Joint disease (DJD) as well as other lesion patterns show on the vertebral column. These patterns include Diffuse Idiopathic Skeletal Hyperostosis (DISH), and Ankylosing Spondylitis (AS). These are progressive diseases that affect the vertebral column; a discussion of the frequency of these skeletal defects is the focus of this study. DISH is categorized as the ossification of the right anterior portion of the vertebral column that results in a smooth surface "bridge" that fuses four or more vertebrae together preserving a space between the vertebral bodies. Ankylosing Spondylitis is defined as a chronic and progressive disease that begins in the thoracic vertebrae and continues into the lumbar region as bones are fused. OA lesions were ranked on a scoring system depending on the percentage of surface area covered and by the number of bones fused. The data collected from this geriatric sample of 720 vertebral bones demonstrates how common these conditions are within this unique



## AAPA Abstracts

Cypriot sample, 21% of males show DISH and 31% of the females show DISH.

### Anglo-Saxon concepts of dis/ability: placing disease at Great Chesterford in its wider context

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The cemetery of Great Chesterford lies to the southeast of Cambridge in East Anglia. A series of 167 inhumations from 161 Anglo-Saxon graves have been re-examined. Pathologies not described in the original skeletal report included cases of tuberculosis and leprosy. For an Anglo-Saxon cemetery, the assemblage has a relatively large proportion of juveniles. Some of these juveniles themselves exhibit pathological conditions, such as extreme periosteal reactive bone growth (potentially hypertrophic (pulmonary) osteoarthropathy). The patterning and location of both the pathologies and the juveniles within the cemetery implies the recognition of unusual and anomalous individuals by and within the local community. Were these individuals considered 'ill' or 'impaired' by the local community? Aspects of the palaeopathology and the bodily implications are discussed. How did the disease processes affect the individuals' lives? Using a series of osteobiographies derived from the Great Chesterford burials, aspects of disability in the Anglo-Saxon period are considered.

### A comparison of genetic and morphometric sex determination techniques in a commingled collection from Byzantine St. Stephen's monastery, Jerusalem

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Commingling of skeletal remains in archaeological contexts can present an obstacle in the reconstruction of demographic profiles, particularly in sex determination. The purpose of this investigation was twofold: a) to determine the ratio of males to females in a commingled assemblage of approximately 250 individuals interred at Byzantine St. Stephen's monastery in Jerusalem (5<sup>th</sup>-7<sup>th</sup> C CE); and b) to compare the consistency of sex ratios garnered from multiple well-preserved osteological indicators, necessary for fragmentary, commingled assemblages. Thus ratios from metric, non-metric, and genetic methods were compared. We analyzed

morphometric features of the cranium, os coxa, and femur, using the Phenice method (n=25), elevation of the auricular surface (n=33), bicondylar breadth of the femur (n=51), and lateral angle and diameter of the internal auditory meatus (n=65). Also, aDNA analysis was conducted on ten carbon-dated lower right second molars from mandibles for which robusticity indicators were evaluated. Results across all methods employed demonstrated a preponderance of males in this collection, supporting the hypothesis that individuals interred at the site belonged to a monastic community. Morphometric analyses occurred at the University of Notre Dame and at L'École Biblique et Archéologique Française de Jérusalem, and aDNA studies were completed at the University of Tennessee, Knoxville.

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### The Effects of Key Individuals on Collective Action

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Cooperation occurs when two or more entities contribute to a common end. When such entities are non-identical, conflict is expected: each individual would benefit from free riding on the 'generosity' of others. Given this conflict, individuals are expected to constrain their contributions relative to others' investments. Nevertheless, mounting evidence from disparate contexts reveals that individuals can vary markedly in their contribution to cooperation without retribution and, more surprisingly, that an increase in investment by one can often be met with an increase by another. No theory exists to explain such unexpected patterns.

In this presentation, using a case-study approach, we highlight four contexts in which individual contribution to cooperate deviate from model expectation. These include (1) contributions to cooperative goals in humans, (2) cooperative hunting in chimpanzees, (3) bi-parental care systems and (4) cooperatively-breeding systems. We suggest that asymmetries in information about what an individual should contribute to a cooperative goal may in part account for these unexpected observations. Finally we suggest that failures of current theories to explain such observations may lie in incorrect assumptions regarding the shape of the benefits function associated with increased investment in

cooperation and the position of individuals on this function.

Our aim is to increase awareness and interest in these unusual observations in the hope that we can better understand when cooperation begets cooperation in animals and humans alike.

### Enhancing physical anthropology graduate education with public outreach in the K-12 classroom

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Graduate programs in physical anthropology often demand singular attention to specialized scientific phenomena. These programs prepare students to become adept researchers and college-level educators, but many lack formal instruction in engagement of the public on research findings and general physical anthropology. My co-authors and I have found that one useful method for graduate students to make research findings relevant and accessible to public audiences is to distill key concepts to a high school level. This serves two purposes: first, it forces graduate researchers to scrutinize their own work, removing jargon and esoteric results in favor of more accessible descriptions of findings; and second, engaging students early, at the K-12 level, increases science literacy and may lead to greater retention of students in STEM industries. We presented high school students, ranging from advanced placement to English-as-second-language classes, from the Boston metropolitan area with one-hour sessions covering human evolution, including active learning and investigation of hominin skull casts. Results of before-and-after surveys from these sessions showed assimilation of complex physical anthropology concepts among the students, including hominin phylogenies and the biological bases of human diversity. Paired t-tests of responses indicated that student understanding of and interest in these concepts increased significantly, as did the abilities of graduate student educators to communicate more clearly and concisely. Thus, we suggest that graduate curricula in physical anthropology programs should strive to incorporate formal education on public outreach, not only for the benefit of the public, but also for that of graduate students as effective communicators.

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**Changes to the face and basicranium in a habitually bipedal Japanese macaque (*Macaca fuscata*)**

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In primates, basicranial flexion is commonly interpreted as an adaptation to fit the brain into a space limited by basicranial length, an idea known as the “spatial packing hypothesis.” However, *Homo sapiens* and other hominin species do not exhibit the degree of flexion expected for their relative brain size. In these species, variation in basicranial flexion might be explained by the need to reposition the foramen magnum underneath the head for bipedal posture or to rotate the palate away from the clivus to maintain airway space in the nasopharynx. It has been difficult to assess these competing ideas since modern humans are the only surviving habitually bipedal primate. In this study, we investigated basicranial flexion and craniofacial morphology in computed tomography (CT) scans of a habitually bipedal Japanese circus macaque and a comparative sample of 63 male Japanese macaque crania obtained from Kyoto University Primate Research Institute’s Digital Morphology Museum. We compared linear and angular measurements of the nuchal region, foramen magnum, basicranium, orbits, and palate. Against expectation, the basicranium, palate, and orbits are less, not more, angled relative to the clivus in the bipedal macaque, whereas lengths of the palate, basicranium, and nasopharynx are not significantly different. We interpret these results to indicate that a lesser degree of basicranial flexion and facial kyphosis functioned to preserve airway patency during the transition to habitual bipedal posture. The need to maintain airway space in the naso- and oropharynges may explain why some hominins have basicrania that are less flexed than expected.

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**Does the strength of adult relationships in pair bonded monogamous siamangs fluctuate over the long term in response to female reproductive status and/or the presence of offspring?**

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Siamangs (*Symphalangus syndactylus*) form lengthy pair bonds in the wild that are reinforced through social activities. To determine whether female reproductive status and the presence of offspring influences social interactions between

the couple, we observed a captive pair of adult siamangs at the El Paso Zoo between 2006 and 2014. The adult male and female experienced a failed pregnancy in 2005 and had two healthy offspring born in December 2007 and May 2011, before the female was placed on birth control in April 2014. Using video recordings and written observations we collected data on the frequency and duration of the couple’s grooming, playing, duetting, spatial proximity and following behaviors, as well as instances of the offspring’s attempts to disrupt the couple’s interactions during the eight year period. The Hinde Index was also used to assess fluctuations in each individual’s social preferences. Our results indicate that social interactions between the couple were most frequent, and therefore the couple’s relationship was strongest, after each offspring was weaned and during the mating period. Interactions between the couple were least frequent when the female was on birth control, pregnant the third time when the male spent more time with the juvenile, and during the first ten months of the second surviving infant’s life when the juvenile spent more time with the mother and infant. Since the adult couple easily thwarted the offspring’s attempted interference with their interactions, we conclude that female reproductive status has the greatest influence over the couple’s social interactions and relationship.

**Prevalence of drifting osteons across mammalian species**

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Drifting osteons are a histological morphotype in which a forming secondary osteon “drifts” transversely through cortical bone while forming longitudinally. Anecdotal observations suggested drifting osteons were common in primates while rare in non-primate mammals, an observation that had yet to be quantified. This study analyzed prepared histological slides of all skeletal elements in order to quantify the prevalence of drifting osteons across a sample of mammals. Our sample included humans (n=120), nonhuman primates (n=24), and non-primates (n=193). Prevalence of drifting osteons in a histological cross-section was calculated as a ratio by dividing the number of identified drifting osteons by the log-scaled total cross-sectional area. We then calculated the mean prevalence ratio for humans ( $\bar{x}$ =1.618, SD=3.311), nonhuman primates ( $\bar{x}$ =1.327, SD=1.489), and non-primates ( $\bar{x}$ =0.049, SD=0.291). T-test results show that the prevalence of drifting osteons is statistically significantly higher in humans than for non-primates ( $t(287) = -6.11, p < 0.001$ ). Primates

taken as a whole also have a statistically significant higher number of drifting osteons than non-primates mammals ( $t(311) = -5.194, p < 0.001$ ). Age has previously been cited as a factor affecting the prevalence of drifting osteons in cortical bone, with periods of growth relating to higher prevalence. However, our study showed no significant difference between the prevalence of drifting osteons in adults (n=136) and subadults (n=49) across all groups ( $t(183) = -0.436, p = 0.664$ ). This research contributes to our understanding of the drifting osteon morphotype, as well as identifying a characteristic to aid in the differentiation of primate and non-primate mammal cortical bone on the histological level.

**Early Mississippian Health: Skeletal evidence from the East St. Louis Mound Center**

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Maize agriculture is one of the hallmarks of Mississippian culture. Maize rapidly became incorporated into the diet, economy, and ideology of people inhabiting the American Bottom region in AD 1050. This was a time of great change characterized by substantial population movements into and out of Cahokia, the consolidation of large populations centered at administrative mound centers such as Cahokia and East St. Louis. This poster investigates the role that maize reliance and population density played in the health of the inhabitants of the East St. Louis Mound Center.

The East St. Louis Mound (ESTL) Center, located 7 km to the east of Cahokia, is one of the largest Early Mississippian administrative centers in the region, second only to Cahokia. Recent excavations by ISAS prior to construction of the New Mississippi River Bridge identified burials and isolated human elements in mound, cemetery, and habitation contexts across this site. The occupation of ESTL spanned only a few generations, and the human remains from ESTL provide a unique opportunity to evaluate the effect of rapid urbanization on the health of the site’s occupants. General indications of infection and stress, including periostitis, porotic hyperostosis, and linear enamel hypoplasias, were fairly common in the ESTL population. Skeletal evidence for tuberculosis and treponematosis were also identified. Dental pathologies, including caries formation and antemortem tooth loss were common and are consistent with a diet heavily dependent upon maize. The skeletal and dental pathologies observed in the ESTL provide new information on Early Mississippian health and diet.

### Baboon grooming behavior in the Kindachacma hybrid zone in Zambia

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Grooming in baboons serves to help solidify and maintain social relationships among individuals, but may also function to express mate choice, thereby having a potential significant impact on reproductive success. In most baboon species, grooming frequencies are highest between females, but intersexual grooming initiated by males occurs largely when females are estrous. This study presents data on grooming behavior of a 64-member group of chacma-kinda hybrid baboons in Kafue National Park, Zambia. Individuals were assessed as Kinda-like, Chacma-like or Mixed (hybrid) based upon phenotypic features. 27 hours of summed grooming data were recorded over 767 observation hours. Since kinda baboons elsewhere are characterized by uniquely high frequencies of male grooming of females across all reproductive states, I examined grooming data in which males were the active groomers. Data were normalized by the time spent observing each reproductive and phenotypic class. The percentage of time spent in female:male grooming was only slightly higher than male:female grooming (46% versus 41%). Most intersexual grooming occurred between Mixed males and Chacma-like females. Males groomed non-estrous females 56% of the time, and early estrous (12%), mid-peak estrous (23%), and lactating (9%) females significantly less. Both the frequencies of male grooming and lack of grooming preference for estrous females indicate that grooming in this group reflects its members' hybrid heritage. DNA studies show that two of these phenotypically mixed males had kinda mitochondria; the genetic study using Y-markers and microsatellites currently under way should further illuminate these behavioral findings.

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### Linear enamel hypoplasia prevalence in wild Virunga mountain gorillas from Rwanda

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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.

Linear enamel hypoplasias (LEH) are assumed to be markers of physiological stress and are ubiquitous among extant great apes. LEH result from disruptions in enamel secretion during development and appear as pronounced horizontal grooves in the outer tooth surface representing a deficiency in enamel thickness. In clinical and experimental settings, LEH have been associated with a variety of stressors, including undernutrition and disease. Previous studies found *Pongo* and *Pan* to have higher LEH frequencies (>90%) than *Gorilla*, with *Gorilla beringei* having the lowest frequencies (11%). The notably low frequency of LEH in mountain gorillas has been attributed to their folivorous diet and reduced seasonal stress or alternatively to acute striae angles at the outer enamel surface. In an expanded collection of Virunga mountain gorillas (N=24) from Volcanoes National Park, Rwanda, we examined epoxy replicas of maxillary and mandibular canines under 20x magnification for LEH presence. Only nearly complete teeth (>80% of crown preserved) with visible perikymata were included. In contrast to earlier studies, we found that 92% of males and 67% of females showed at least one LEH. Three observers (KM, DGS, SM) scored LEH presence independently from high-resolution photographs; agreement between sets of paired observations was 75-92%. Preliminary measurements from associated depth profiles suggest a high prevalence of shallow defects contribute to discrepancies among observers. Histologic analysis of this sample is underway examining the influence of enamel growth parameters and documented life events on enamel defects with the potential to address etiology and morphology of LEH in mountain gorillas.

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### 3D Geometric Morphometric Analysis of the Tibial Plateau for Sex Determination

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Though the human tibia has frequently been studied to answer questions regarding the evolution and mechanics of bipedalism, its value for determining sex has often been overlooked in favor of more established methods that rely on the pelvis. However, previous studies using femora and tibiae for sex determination have been highly successful, though they focus mainly on general size and shape differences. These differences play a role in the type of mechanical loading and activity stress that an individual has

undergone throughout life, varying widely among different populations and showing a marked reduction in more sedentary populations when compared to more active populations, such as hunter-gatherers.

This study uses 3D geometric morphometrics to examine the articular surfaces of the tibial plateau of 30 individuals to determine if there are differences in curvature. Discriminant function analysis results indicate definitive variation between males and females, and during cross-validation, females had an accurate classification rate of 60% while males were slightly less at 53.8%. It is expected that with further investigation, females will display more pronounced curvature on the medial articular surface due to their wider hips and greater valgus angle of the femur, while males will display more uniform curvature throughout both articular surfaces. The expected shape differences in the articular surfaces can be used to determine sex if more sexually dimorphic bones are missing, or to determine the type of activity most prevalent in past populations.

### Bringing Wine to the Feast: Diet and Status of Late Iron Age and Early Roman Individuals from Winterborne Kingston, UK

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Excavations at a Late Iron Age to Early Roman site in Winterborne Kingston, UK, have revealed a wealth of finds indicative of intermittent occupation during a period of significant change. In addition to various artifacts and the foundations of British and Roman buildings, a large number of human remains were found including over forty sub-adult remains and eighteen adults. The adults were buried with a variety of grave goods and in both standard crouched and deviant positions. Burial differences may indicate Roman influence and differences in status among the North Down Farm individuals. Stable isotope ( $\delta^{13}\text{C}_{\text{col}}$  and  $\delta^{15}\text{N}_{\text{col}}$ ) analyses were undertaken on a sub-set of the burial population and faunal remains in the hopes of revealing the influence of cross-culturalization, status, and sex on diet.  $\delta^{13}\text{C}_{\text{col}}$  values for all sampled individuals are consistent with a terrestrial  $\text{C}_3$  diet (-22.01 ‰ to -20.06 ‰), but statistically significant differences were observed in both carbon and nitrogen values within the burial population. Enriched  $\delta^{13}\text{C}_{\text{col}}$  values were associated with crouched burial positioning and unknown burial positioning, and with individuals determined to be of intermediate and high status. Enriched  $\delta^{15}\text{N}_{\text{col}}$  values were observed among females, low-status individuals, and deviant burials. Nitrogen enrichment may suggest that women were consuming foods from either higher trophic levels or of greater variety

than men. The social implications of these results will be discussed.

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### **In A World of Allomothers, Privileging The Mother-Infant Dyad: Intellectual and Political Challenges of Giving All Their Due in Evolutionary Narratives**

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Models of human behavioral evolution have shifted in the last decade giving appropriate prominence to the role of allomothers and the rise of cooperative breeding. Here I consider how our increasing emphasis on the critical role of individuals other than the mother whose shared care significantly reduced daily maternal energetic demands needs to be balanced against the singularly critical contributions mother herself plays in maximizing the chances of her infant's survival. Using empirical data from my own laboratory studies of breastfeeding and co-sleeping i.e. *breastsleeping* mother-infant dyads, sensory-based exchanges are demonstrated to physiologically regulate the infants breathing, body temperature, heart rate and breastfeeding frequency and duration, all clinically positive changes mostly accessible to the infant within the context of the dyad. Also discussed are both the advantages and disadvantages of evolutionary narratives when used as rhetorical arguments, on one hand privileging the on-going importance and unique biology of humankind's oldest and most successful feeding and sleeping arrangement, but on the other, potentially threatening an appreciation of maternal agency and woman's reproductive rights.

### **Beyond the Bones of Baikal: 18 Years of Multidisciplinary Bioarchaeological Research in Siberia**

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For almost 20 years, and with the support of over \$7.5 million dollars in research funding, the large, multidisciplinary, and international Baikal-Hokkaido Archaeology Project or BHAP (formerly the Baikal Archaeology Project or BAP) has been conducting bioarchaeological research in eastern Siberia (BHAP: <http://bhap.artsrn.ualberta.ca/>). At the core of this project is an enormous collection of biological (osteological, bone chemistry, DNA, etc.) data representing over 500 individuals from over 20 cemetery sites, as well as a broad range of associated contextual (archaeological,

paleoenvironmental, climate modeling, ethnographic, etc.) data. To date, however, successful integration of these data into truly synthetic accounts has been limited. In this poster, we survey the entire body of peer-reviewed literature produced by the BHAP/BAP project (100+ books, journal articles, and book chapters) along with corresponding organizational structure over the project's evolution (taken from internal project documents), to identify specific factors that have either facilitated or limited the integration of its disparate datasets. We conclude that many of the important limiting factors (e.g., varying temporal and spatial scales of the data, different intellectual traditions between international partners, language issues, etc.) can be managed through careful attention to the project's organizational structure. As a particularly enduring example, BHAP provides a valuable case study of the problems, limitations, and benefits of large, multidisciplinary and international projects in bioarchaeology.

*The project analyzed in this study has been largely funded by the Social Sciences and Humanities Research Council (SSHRC) of Canada.*

### **New partial cranium from an early Miocene locality at Lower Kapurtay**

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Recent fieldwork as part of the REACHE project has resulted in many new catarrhine primate specimens from early Miocene localities associated with the Tinderet volcano in Western Kenya. A survey of localities in 2013 relocated many of the traditional collecting areas, and a surprising density of fossils at a small site near the base of Kapurtay hill prompted us to undertake new excavations there in 2014. A preliminary geological survey identified eight stratigraphic units in only a few meters of section at the exposure, most units lacking distinct boundaries. Approximately 90 square meters were excavated during the 2014 field season, sampling the five uppermost units. Each stratigraphic unit contained numerous fossilized bone fragments, with primates representing the second-most abundant group (behind rodents) among identifiable remains. More than 50 primate specimens were recovered from this site, including a new partial cranium referred here to *Rangwapithecus gordonii*. This unusual specimen preserves both deciduous and adult teeth, aspects of the lower and mid-face, plus neurocranial

fragments. Two phalanges recovered adjacent to the cranium may also be associated. Significant cranial remains are rare for early Miocene primates, particularly those from the Tinderet localities, and this new specimen expands the known diversity of catarrhine morphology while providing new information about sexual dimorphism and ontogeny in a relatively poorly known species. The abundance of primates at the Lower Kapurtay site underscores the importance of continued and expanded excavations there in the future.

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### **Reconstruction of the morphology, distribution and role of *Cryptoprocta spelea* as a predator of extinct lemurs**

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With the extinction of the giant lemurs and other megafauna on Madagascar came the disappearance of a number of formidable megafaunal predators, including a crocodile, large raptors, and a mammalian carnivore (*Cryptoprocta spelea*). Radiocarbon dating has confirmed that at least some of these predators, including *C. spelea*, as well as their prey, survived into the human period. Little is known about these predators; there is debate regarding whether giant lemurs fell victim to them. Yet predator presence or absence is often strongly influenced by competition with other predators and interactions with prey, and the extinctions of prey and predators are likely linked.

We studied 97 bones of *Cryptoprocta* and 747 extinct lemur humeri and femora from six sites in four ecoregions (spiny thicket, succulent woodland, dry deciduous forest, and central highland). We distinguished bone damage likely made by crocodiles, mammalian carnivores, and raptors. Our data confirm strongly significant differences in body mass and forelimb robusticity between *C. spelea* and its extant relative, *C. ferox*. We determined the relative prevalence of mammalian carnivory by prey characteristics and ecoregion. Frequencies of mammalian carnivore damage were higher than expected in succulent woodlands but lower than expected in all other ecoregions. Lemurs as large as *Palaeopropithecus* and *Megaladapis* show signs of mammalian carnivore damage, but most mammalian carnivore damage is found on mid-sized lemurs, including *Pachylemur*, while the



slower and larger *Palaeopropithecus* and *Megaladapis* were more likely to have been preyed on by crocodiles.

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**Development of social bonds through play among captive juvenile and adult bonobos (*Pan paniscus*)**

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Play behavior is common in most social species, but usually is primarily a behavior that defines the juvenile life-history stage and is rare to absent in other age groups. Play in bonobos (*Pan paniscus*) is unusual in that it occurs throughout all ages. Traditionally, researchers thought the primary benefit of play was physical development. However, more recent research suggests that social benefits, such as the creation and maintenance of social bonds, may be just as, if not more important. We explore the social benefits of play in bonobos by examining the development of play relationships in juvenile-adult dyads at the Cincinnati Zoo. Most studies on play focus on juvenile-juvenile dyads, but at the Cincinnati Zoo, juveniles are separated from one another and only have adults as potential play partners. This provided the unique opportunity to observe juvenile-adult interactions and to measure how the interactions developed as the juveniles aged. We observed a male and female juvenile from Feb - Aug 2014, and found that their preferred play partners were also their preferred partners for all other social interactions, supporting the hypothesis that play is an important component in the creation of social bonds. Hinde's indices demonstrated that both the juvenile and adult partners were equally responsible for initiating play interactions (average = 0.025). This supports the hypothesis that play provides important social benefits to adults as well. We discuss the potential impacts the social composition in this captive environment may have on the social development of the juveniles.

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**Improving Accuracy, Precision, and Efficiency in Analysis of Osteon Cross-sectional Shape**

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Variations in secondary osteon (SO) cross-sectional shapes help determine species affiliations, estimate age, and decipher load history. SO cross-sectional shape is expressed as "circularity index" [ $CI=4\pi(\text{area}/\text{perimeter}^2)$ ; 1.0=perfect circle] and can be measured in various ways. But which method is the most accurate and efficient? Sixty osteons (5 osteons/image; 8 deer calcanei and 4 human femora; backscattered electron images) and 9 virtual osteons (created using Photoshop) were traced/measured. Each trace followed a predetermined cement line made by: (1) opening each image in Photoshop, (2) selecting the osteon using quick select tool, and (3) outlining the SO periphery with black and filling with white. Using ImageJ, methods included: (1) wand tracing tool followed by smoothing (fit spline vs. interpolate), (2) manual tracing with stylus on a Windows-based tablet (ASUS M80T) using freehand selections tool, and (3) manual tracing with the polygon selections tool (minimum 20 points). Data from virtual osteons suggest that fit spline could be problematic by over smoothing when crenulations are present, although not by much (mean CI difference =0.032 vs. interpolate). Although when using the wand tool, fit spline or interpolation can significantly affect perimeter (hence CI); but SO *area* measurements are not significantly affected. Therefore, the two best methods are: (1) Windows tablet running ImageJ/freehand tool, without the fit spline or interpolation functions, and (2) wand trace tool with interpolation function. Mean CI difference of these two methods =0.007 and their traces closely follow the cement line. Windows-based tablet also bypasses the need to first paint the SO in Photoshop, which enhances efficiency.

**The role of human evolution in science education: Impacts on students and the public**

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Physical anthropologists are uniquely positioned to encourage and facilitate education on human evolution, a topic of great general interest. Humans can be a "hook" to introduce students to the nature and interconnectedness of science. At the same time it is specifically *human* evolution which most provokes opposition to the general concept of evolution in American society. From the time of Darwin, through the Scopes-era laws of the 1920s and the "equal-time" battles of the 1970s-80s, and right up to today, scientific conclusions about the origins of humans have consistently sparked determined opposition, usually correlated with particular religious traditions, in some social circles. A significant proportion of this opposition is rooted neither in ignorance nor stupidity.

Comparisons of the rhetoric employed over the last century by anti-evolutionists reveal the essentially unchanging basis of their opposition, even while their tactics have adapted to a changing legal and educational landscape. A review of anti-evolution legislation proposed

from 2001 to 2013 finds 163 bills in 31 states, a few of which have become law and more which nearly did so. Local-level opposition to evolution education continues today in every state. While scientific knowledge and educational resources about evolution increase exponentially, opposition to the concept remains robust, an apparent paradox. Traditional formal education by physical anthropologists and especially broader outreach to the public, including policy-makers and voters, are necessary to promote scientific understanding, even if they are not sufficient by themselves to resolve this problem.

**Examining the links among fruit signals, nutritional value, and the sensory behaviors of wild capuchin monkeys (*Cebus capucinus*)**

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Senses serve as the interface between animals and the external environment and are critical during food detection and evaluation. Most primates consume ripe fruits and are typically viewed as "visual" animals. The non-visual senses, such as smell (olfaction) and touch (somatosensation), have been undervalued in the study of primate sensory ecology. Yet primates routinely sniff and squeeze fruit during assessment before consumption. We integrate foraging data from a 12-month behavioral study of white-faced capuchins (*Cebus capucinus*) with olfactory (volatile organic compounds -VOCs), haptic (force resistance) and visual (spectral reflectance) signals of fruit ripeness that are available to primates, along with fruit nutrition composition at different ripeness stages. We find: 1) distinct odor profiles (number, diversity and total VOCs) in fruits at different stages of mechanical ripeness; 2) that haptic (mechanical) and olfactory (VOC) changes in fruits are significantly related to nutritional ripening (n=7, p=0.0042); and 3) that olfactory and mechanical cues are a better indicator of ripeness than visual (color and size) changes are for some fruit species. Specifically, color changes can occur prior to fruit softening, final odorant shifts, and before the fruit is nutritionally ripe. These results support a role for color in long-distance signaling to attract foraging animals, which must then use different close-range evaluation methods (touching and sniffing) to assess the edibility of individual fruits. This study contributes to our knowledge about the foraging cues available to



primates and other frugivores, and how multiple sensory modalities can inform food assessment and selection.

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#### **Paternal genetic structure in contemporary Mennonite communities from the American Midwest**

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Short tandem repeat (STR) markers from the non-recombining region of the Y-chromosome (NRY) are known to be informative for determining paternal genetic ancestral patterns in recently derived human populations. Mennonites represent a major branch of the Anabaptist movement that began in northern and central Europe in the 16<sup>th</sup> century and maintain a well-documented migration and genealogical history. Provided this historical information, we investigated the genetic relationship of 17 NRY STR loci within five Mennonite communities from Kansas (Alexanderwohl, Lone Tree, Garden View, and Meridian) and Nebraska (Henderson). We sought to determine if patterns of fission/fusion along familial lines persisted with paternal genetic information as evidenced through other genetic markers. NRY haplotype information was obtained for 94 individuals and genetic variation were analysed and compared across the five study populations and comparative European populations. NRY haplogroups were assigned using a Bayesian allele frequency approach. A total of 92 NRY haplotypes were detected with none shared across these communities. The most prevalent NRY haplogroup was R1b, which occurred in 56% of the entire sample. Eight additional NRY haplogroups (E1b1b, G2a, I1, I2, J2a1, L, Q, and R1a) were detected in smaller frequencies. In contrast to mtDNA, multi-dimensional scaling of NRY data displayed no patterns of population subdivision of communities into congregations. These NRY genetic profiles provide additional information regarding the recent migratory history of Mennonite communities and provide additional evidence for the fission along paternal lines resulting from disagreements over theological issues that caused families to split and form new congregations.

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#### **A hard knock life: Social interactions of adopted orphan *Lemur catta***

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Adoption of orphans is common in haplorhines. Although adoptive parents may increase their indirect fitness by investing in orphans, they should still invest more in their own offspring, such that orphans should be disadvantaged compared to non-orphans. Indeed, adoptive mothers are more rejecting of orphans than their own living offspring, and orphans grow slower, emigrate earlier, and achieve lower social status as adults. But orphans are expected to employ behavioral strategies to circumnavigate these obstacles. Haplorhine orphans manage to achieve clinging, grooming, and proximity patterns comparable to their non-orphan counterparts, and can eventually become fully incorporated into their adoptive mother's social network. Adoption has been reported for three strepsirrhines, but information on the social interactions of adoptees is scant. I present the results of generalized linear mixed models comparing the social interactions of two *Lemur catta* infants adopted by adult females with living offspring to 27 non-orphan infants in the first two months of life. Challenges faced and strategies used by adoptees were similar to haplorhine orphans. Orphans received markedly more agonistic behavior (bites, cuffs, etc.) from others ( $X^2_1 = 23.7$ ,  $P < 0.001$ ) and were groomed less than non-orphans ( $X^2_1 = 116.74$ ,  $P < 0.001$ ), but achieved comparable time in proximity to others (e.g., contact  $X^2_1 = 3.7$ ,  $P = 0.06$ ) and only slightly less time on the nipple than non-orphans (29% vs 33%). Differences in rates of approaching and leaving others suggest that orphans made strategic behavioral adjustments to meet their needs in a relatively rejecting social milieu.

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#### **Back to basics: Understanding the role of biological processes in adult skeletal age estimation**

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Established skeletal age estimation methods have low reliability when applied to adults over the age of 40 years. After the age of 40 years, osteological changes are not always associated with specific stages of aging. Rather, they are strongly affected by factors that are not typically knowable in archaeological or forensic contexts: lifestyle, environment, and genetic predispositions. Recent studies have focused on refining statistical formulae to improve accuracy

and precision (e.g. Bayesian statistics, cumulative probit models). While this work has made important contributions to the field, it has limitations. This paper suggests a return to basics: focusing on the underlying biological processes that inform skeletal changes in order to produce greater accuracy in adult age estimations.

This study applied the Buckberry and Chamberlain and Rougé-Maillart et al. methods to 764 skeletons from the Hamann-Todd and Bass Collections. Individuals ranged from 1.30m to 1.93m and 24kg to 99.8kg. ANOVAs were used to determine differences among individuals of varying body sizes. Results show that as body size increases, the surface texture, porosity, and apical activity scores are higher for larger individuals compared to smaller individuals. This study also found that femoral length and femoral head diameter are accurate proxies for stature and body mass. These findings show that body size affects the bone remodelling rates of the traits used in age estimation, and that understanding how body size influences underlying bone biology can improve the accuracy of adult skeletal age estimations.

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#### **Analysis of human rib fracture mode**

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Traumatic thoracic events are common occurrences that may involve injury to vital organs. Reconstruction of events contributing to rib fractures is complicated by rib morphology and angle. Still, establishing these events may be imperative in forensic contexts especially when soft tissue is absent. Despite extensive study of rib fractures across anthropological, clinical, and injury biomechanics literature, rib fracture patterns are not yet fully understood. Predictions of rib fracture patterns depend on understanding potential correlations between mode of failure with individual characteristics, specifically age and sex. In addition, rib specific characteristics and biomechanical properties should be considered. In this study, 68 excised ribs from 51 individuals, ranging from 6 to 99 years old, were experimentally tested in a custom-designed fixture simulating a dynamic anteroposterior impact to the thorax. A total of 83 fractures were examined on pleural and cutaneous surfaces, then divided into four fracture mode categories: transverse, oblique, butterfly, and buckle. Results indicate that across sex and age, oblique fractures were most prevalent, followed by butterfly fractures. The exception was ages 20 to 29, which exhibited more butterfly fractures. Further, transverse fractures were only present in

individuals past the age of thirty. This study implicates that age has some influence on rib fracture mode of failure and may be useful to interpretation of rib fracture patterns in forensic contexts.

**Lucy plus one: Intermingling of a second individual in the spinal column of A.L. 288-1**

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In the description of postcranial material associated with the A.L.288-1 partial skeleton popularly known as Lucy, Johanson et al. (1982:432) noted that the A.L.288-1am thoracic neural arch fragment stood out from the other fossils because it was "polished or even 'water-worn' and is the only specimen from A.L.288 with these characters." This observation led us to examine if this fossil was correctly attributed to Lucy.

A.L.288-1am most closely resembles a hominin T2 vertebra; however, it falls well below the expected intra-individual size pattern for a given spinal column in adult (N=61) and subadult humans (N=13), African apes (N=42), and fossil hominins (N=5) when compared to the other A.L.288-1 vertebrae. Consequently, this vertebra does not appear to belong to Lucy and must belong to a second, smaller individual. We show that the erosion, possibly from carnivore ingestion and partial digestion, is minimal and likely inconsequential to our analyses.

We demonstrate that this vertebra exhibits characters absent in hominoids but common in baboons, explaining its anomalous fit within Lucy's axial skeleton. This vertebra is best attributed to the genus *Theropithecus*, which today is only represented by the gelada baboon, but was the most abundant cercopithecoid in the KH-1s level where A.L.288-1 was discovered. Quantitative analyses also situate this vertebra among baboons.

Although one partial vertebra was erroneously attributed to Lucy, aspects of vertebral morphology are particularly similar in humans and baboons, explaining why it escaped notice for 40 years. However, we confirm that other A.L.288-1 vertebrae were correctly attributed to Lucy.

**New insights to the Neandertal obstetrical mechanics**

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Birth is a major biological event, with many issues at stake. In the anatomically modern Human, it is also a fundamental cultural moment, with various practices and rituals. Biologically speaking, the modern delivery (named rotational birth, because of the movements made by the fetus during the expulsion) has long been considered an exception among human lineage but several recent studies has re-opened the debate.

At the end of the years 2000, the technical progresses of virtual anthropology as well as the discovery of new materials have led to a new rise of paleo-obstetrical works applied to Neandertal population. Various hypotheses have been suggested which can all be summarized in one question: did this population have modern-type obstetrical mechanics?

This study uses a paleo-obstetrical approach to analyse three Neandertal pelvises (Regourdou 1, Kebara 2 and Tabun C1) linked with four neonates (Mezmaiskaya 1, Le Moustier 2 and Roc de Marsal 1 and Pech de l'Azé 1). Using the tools of modern obstetrics (confrontation of pelvic and cephalic diameters) and geometric morphometrics (in particular Procrustes analyses), we attest the presence of a rotational birth in Neandertal population. However, some characteristics of this birth differ from the modern Human, for example concerning the risk of dystocia or the timing of rotation.

The existence of modern-type obstetrical mechanics in Neanderthal raises different issues of physiological, demographical but also cultural nature. It also offers the opportunity to question the notion of bio-cultural modernity.

**Insights into trunk modularity: the relationship between lumbar vertebral dimensions and pelvic shape in recent humans and chimpanzees**

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In hominoids the vertebral column and pelvis share strong functional pressures for locomotor efficiency. Here I explore the pattern of integration between lumbar vertebral and pelvic shape in humans and chimpanzees to assess (a) whether the weight-bearing demands of bipedality lead to stronger covariation in humans, and (b) if human females exhibit similar patterns of covariation as males. To address these questions I measured the lumbar vertebrae and pelves of a diverse sample of adult *Homo sapiens* (n=510; 210 females, 300 males) and *Pan troglodytes* (n=80; 50 *P.t. troglodytes*, 30 *P.t.*

*schweinfurthii*). I collected caliper measurements from the vertebrae and extracted linear measurements of the articulated pelvis from three-dimensional coordinates collected using a Microscribe G2X digitizer. The R statistical software package was used to construct correlation matrices and calculate the variance of eigenvalues (VE) to assess the strength of integration between regions.

Contra to expectations, *Pan* demonstrates stronger levels of covariation between the lumbar vertebrae and pelvis than *Homo* (e.g., L1-pelvis VE: *Pan*=2.834, *Homo*=1.768; L3-pelvis: *Pan*=2.900, *Homo*=1.849), which supports predictions of strong trunk integration in non-human primates but suggests that bipedality (and other selective pressures) in hominin evolution actually led to reduced integration in the human trunk skeleton. Human males exhibit slightly higher levels of covariation between the pelvis and lumbar vertebrae than do females (e.g., L1-pelvis VE: males=1.756, females=1.522; L5-pelvis: males=1.815, females=1.5734), which suggests females benefit from the plasticity of a more modular trunk skeleton that allows for protection of obstetric dimensions in the face of additional selective pressures.

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**Red-hot males: Sexual strategies of high-ranking male rhesus macaques (*Macaca mulatta*)**

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Sexual selection explains the evolution of behavioral and morphological traits that influence an individual's reproductive rate, which can take place both intra- (e.g. male-male competition) and inter-sexually (e.g. female mate choice). These two mechanisms can covary, such as when females are more attracted to males who win physical contest. Recent observational and experimental work has shown that rhesus females are more attracted to dark red males, which does not covary with dominance rank. Here, we examine whether inter-male variation in skin coloration contributes to the variation in mating success of high-ranking males. More specifically, we test the prediction that high-ranking males exhibiting dark red skin color receive more sexual solicitation and mate more frequently than pale pink ones. To do so, we

collected behavioral observations and color images during the mating season for the top-ranked males of 9 social groups (N=21) of free-ranging rhesus macaques (*Macaca mulatta*) on Cayo Santiago, Puerto Rico. We use GLMs in SPSS with a significance level of 0.05 to test variation in male reproductive rates and the potential behavioral and physical traits that may be impacting these rates. We found inter-male variation in time spent consorting ( $p=0.000$ ,  $F=10.115$ ) and yearly reproductive rates ( $p=0.000$ ,  $F=24.323$ ). However, these rates are not associated with variation in affiliative behaviors ( $P=0.560$ ,  $F=0.704$ ) or agonistic interactions ( $p=0.395$ ,  $F=1.040$ ). Instead, a combination of both behavioral traits, rank, and skin color impacts male reproductive success. Thus, sexual selection results in a combination of behavioral and morphological traits that influence male sexual strategies.

#### Cell number and volume of primary visual cortex in primates

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Determining the cellular composition of specific brain regions is integral to our understanding of the function of the brain because it sheds light on the circuitry that makes up the neurobiological sensory systems that produce behavior. It is therefore useful to identify the extent to which the cellular composition of a single brain region varies across related taxa. In this study, we estimated the volume and the number of cells in the primary visual cortex (area 17 or V1) across primates. Specifically, we used the optical fractionator to estimate the number of cells in V1 and the Cavalieri principle to estimate the volume of V1 from brain slices stained for Nissl substance. Our results indicate that the volume of V1 varies from approximately  $0.2 \text{ mm}^3$  to  $7.8 \text{ mm}^3$ , and that the total number of cells in V1 ranges from approximately 80 million to 1.8 billion. Our data indicate that the density of cells in primate V1 range from approximately 200,000 cells/ $\text{mm}^3$  to over 500,000 cells/ $\text{mm}^3$ . In addition, our results suggest that the number of cells in primate V1 scale as a linear function of V1 volume and that variation above or below this ratio between the size and the number of cells in V1 may be related to differences in behavioral ecology.

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#### New insight into the paleoenvironment and mechanisms of taphonomic accumulation at Buluk, early Miocene, Kenya

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Recent work at Buluk, early Miocene, Kenya, provides new detailed insights into the paleoenvironmental context of the Buluk primates. Buluk is well-known in paleoanthropology because the site yields evidence of primitive catarrhine monkeys (cercopithecoids) and apes (hominoids), from a time period shortly after divergence of the two lineages but before the evolution of modern forms. Fossils at Buluk are recovered from ~17 Ma sandstone and pebble-conglomerate point bar and channel-fill deposits associated with a mature meandering river system. Development of the river system after ~17 Ma was terminated by a major pyroclastic eruption causing the catastrophic demise of animal life. Rhyolitic deposits completely in-filled the shallow valley and mantled the surrounding subdued topography, producing a near-continuous chronostratigraphic marker. The preserved riverine sediments, in contrast, are of restricted aerial extent. Silicified tree trunks preserved in ash-flows indicate that the river valley was at least partially wooded. Some river channels retained more or less permanent water as indicated by the presence of crocodiles and turtles, but there is sedimentary evidence that other channels carried water more episodically. Evidence of dermestid beetle infestation of some bones indicates that the animals died on the flood plain, where carcasses decomposed sub-aerially within a temperature range of 18-30°C. Post-depositional winnowing and transport by water incorporated the bones into river channels, with the relative completeness and condition of skeletal elements suggesting that carcasses were not transported far after death. Localized, particularly rich vertebrate "bone beds" were formed by the re-working of earlier point bar deposits.

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#### Using Dental Morphology to Assess Ancestry at an historic Indiana site

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When determining ancestry in skeletal remains, it is common for traits to be ambiguous or indeterminate. Such is the case for an historic site from northwestern Indiana. The site, 12T1198, is thought to be associated with Fort Ouiatenon, a French fur trading post first constructed in the early 1700s. It consists of accidentally discovered human remains that washed out of the Wabash River bank within a mile of the fort. Artifacts found near the remains include coffin nails as well as Native American lithics. The human remains ( $n = 3$ ) were

fragmented and incomplete and displayed ambiguous indicators of ancestry. This study determines ancestry of these individuals using dental morphology. Standard procedures (i.e., ASUDAS) were followed for identifying and scoring dental non-metric traits. Following Edgar (2005) the burials from site 12T1198 display overwhelming evidence of European ancestry with Burial 1 showing 100% European probability, Burial A showing 94% European probability, and Burial B showing no significant results. The European designation of these burials points to an association with Fort Ouiatenon. However, further analysis of the remains (including radiometric dating) is needed to determine with confidence the association of the remains with the fort. If this can be confidently determined, these remains represent the oldest non-native burials in the state.

#### Hidden Heterogeneity in a Modern Skeletal Sample

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The theoretical concept of hidden heterogeneity was first discussed by Wood and colleagues in 1992. This is the notion that individuals within a skeletal sample are with respect to frailty, or age-specific risk of death. Hidden heterogeneity is influenced by genetics, socioeconomic status and health status. These factors are not observable on skeletal material and are thus hidden from the anthropologist, yet can strongly contribute to risk of death within a cohort.

This project questions whether diabetes, which is not directly observable skeletally, increases the risk of death from cancer. A total of 466 (201 females and 265 males) individuals from the William M. Bass Donated Skeletal Collection were statistically analyzed. This modern collection is useful as medical history of these individuals is reported that would otherwise be unknown in an archaeological collection. Individuals with a reported presence of cancer and diabetes were included in the statistical analyses. Odds ratios indicate that diabetes does increase the likelihood of cancer; however there are no statistically significant sex differences. This suggests that it is possible for a skeletally unobservable trait to contribute to risk of death from a condition that may affect the skeleton. Future studies will consider other factors related to hidden heterogeneity and apply more robust statistics such as hazards analysis.

#### Three Age Indicators of the Adult Human Pelvis and the Influence of Occupation on Morphology

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Few studies address whether there are trends in physical activity's influence on the morphology of age indicators. The adult human pelvis is useful because it contains three age indicators. If certain age indicators are demonstrated to react in specific and systemic ways, then it might be possible to see the influence of activities across populations or samples. This may improve our understanding of past activity. I used four different pelvic aging methods—the Suchey-Brooks pubic symphysis, Osborne auricular surface, the Rissech, and Calce acetabulum methods—to determine if activity, approximated by occupation, influenced the age estimates from any of the three indicators and how. White male and female individuals (N=212) with documented occupation and known age-at-death from the Bass Collection (University of Tennessee, Knoxville) were used to test these methods. ANCOVAs were used to test the relationship between occupation and age estimates. Results show the relationship between occupation and the Suchey-Brooks and Calce methods' estimates were significant ( $p < 0.05$ ). Individuals with non-manual occupations were overaged. There was no significant relationship between occupation and estimated age for the Osborne or Rissech methods ( $p > 0.05$ ). When segregated by sex, the male samples of each aging method showed no relationship between occupation and estimated age, whereas the female samples showed a significant relationship for the Osborne method ( $p < 0.05$ ) and a borderline significant relationship for the Rissech method ( $p = 0.09$ ). Future studies with larger test samples and other indicators should be conducted to further demonstrate the influence physical activity has on age indicator morphology.

#### Insights into Native North American Admixture Patterns from Whole Genome Sequencing

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While many genetic studies have investigated the origins and early history of Native Americans, less attention has been given to recent history and the impact of post-European contact admixture on Native American genomic diversity. In particular, genome-wide patterns of admixture have been poorly characterized in Native North American populations due to the

paucity of genomic data from these populations. Because the British, French, Spanish, Russian, and other European powers established colonies in different regions of North America, Native Americans in different regions of the continent may have experienced gene flow from different European sources, resulting in varying demographic histories in each region.

In this study, we investigated admixture patterns in three regions of North America (the southern US, the Pacific Northwest, and Alaska) by analyzing newly collected whole-genome sequences from six Native Americans. We compared these sequences to new whole-genome sequences from three Siberians and to published whole-genome sequences from populations with Native American ancestry and non-native populations. We assessed the proportion of admixture in the Native North Americans, and our analyses showed varying degrees of admixture in the different geographic regions sampled. Principal component analysis suggested that while these Native North Americans are most genetically similar to Central and South American populations, they are also more similar to East Asian populations than are the Central and South Americans. Finally, we performed demographic modeling to identify when different admixture events may have occurred and whether the similarities with East Asians are due to shared ancestry or more recent admixture events.

#### Investigating the extent to which enthesal changes reflect bone remodeling at the modern human femoral midshaft

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The principles underlying bone functional adaptation are well established, although recent studies suggest that the bone-tendon-muscle relationship may be more complex than originally thought. Anthropologists examine the morphology of “muscle markers” or entheses to infer behavior, but the extent to which enthesal change reflects the underlying bone remodeling remains largely unexplored. Here, a classic muscle marker scoring method is evaluated using histomorphometry on a large medieval human archaeological sample from Canterbury, UK.

Adult femora (n = 441) were grouped into different (absent, hypertrophy, stress lesion) adductor longus (AL) and adductor magnus (AM) enthesal categories. Intact, fragmentary, and osteon population densities, as well as osteon area, Haversian canal area and diameter, and osteocyte lacunae density were recorded in

sections removed from the midshaft linea aspera region and compared across the enthesal categories using univariate inferential statistics.

The histology variables did not consistently correspond with outer enthesal morphology (AL:  $p = .000 - .012$ , AM:  $p = .000 - .131$ ), particularly when age (AL: young  $p = .007 - .883$ , middle-aged  $p = .000 - .101$ , AM: young  $p = .022 - .591$ , middle-aged  $p = .007 - .271$ ) and sex (AL: females  $p = .004 - .655$ , males  $p = .000 - .093$ , AM: females  $p = .049 - .934$ , males  $p = .011 - .617$ ) were accounted for in the analysis. Results indicate that biomechanical inferences gained from the underlying bone growth mechanism may not support conclusions drawn from macroscopic observations, suggesting the need for multi-methodological approaches in future studies.

#### The relationship between cephalopelvic proportions and sexual dimorphism in the birth canal and non-obstetric pelvis in anthropoids

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The extent to which obstetric selection has shaped the primate pelvis is poorly characterized. As important as birth is hypothesized to be in shaping pelvic morphology, we actually know relatively little about how birth affects the anthropoid pelvis, especially outside the birth canal. This study tests the hypothesis that large cephalopelvic proportions are related to dimorphism in the obstetric and non-obstetric pelvis. Landmark data for 118 anthropoid specimens were analyzed [Large cephalopelvic proportions: *Ateles geoffroyi* (n=4), *Homo sapiens* (n=13), *Hylobates lar* (n=17), *Macaca fascicularis* (n=10), *Nasalis larvatus* (n=13), *Papio cynocephalus* (n=10), *Saimiri sciureus* (n=14); Small cephalopelvic proportions: *Alouatta palliata* (n=5), *Gorilla gorilla* (n=13), *Pan troglodytes* (n=11), *Pongo pygmaeus* (n=8)].

Birth canal dimensions were significantly larger in females than males ( $p < 0.05$ ) within those species having large cephalopelvic proportions, but not in species with small proportions. Birth canal shape, quantified using principal components analysis of landmark data, was also dimorphic in species with large cephalopelvic proportions (all p-values  $< 0.05$ ), but not for species with small cephalopelvic proportions. Patterns of obstetrically-related dimorphism, quantified using Euclidean distance matrix analysis, were shared among phylogenetic groups (New World monkeys, Old World monkeys, and apes). Finally, using similar methods, dimorphism in the non-obstetric pelvis did not correspond predictably to either the presence of birth canal dimorphism or large cephalopelvic proportions. These results suggest that large cephalopelvic proportions influence dimorphism in birth canal size and shape, but not



dimorphism outside the birth canal, and that patterns of dimorphism are shared within phylogenetic groups.

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#### **Diet and mobility of an Iron Age population in Switzerland – Stable carbon, nitrogen and sulphur isotope analysis of the human remains from Münsingen**

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The 220 abundantly equipped burials from the Late Iron Age cemetery of Münsingen (420 – 240 BC) marked a milestone for Iron Age research. The evident horizontal spread throughout the time of occupancy laid the foundation for the chronology system of the Late Iron Age. Today the skulls of 77 individuals and some postcranial bones are still preserved. The aim was to obtain information about nutrition, social stratification and migration of the individuals from Münsingen. Stable isotope ratios of carbon, nitrogen and sulphur were analysed. The results of 63 individuals show that all consumed C<sub>3</sub> plants as staple food with significant differences between males and females in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values. The results indicate a gender restriction in access to animal protein. Stable isotope values of one male buried with weapons and meat as grave goods suggest a diet with more animal proteins than the other individuals. It is possible that he was privileged due to high status. Furthermore, the  $\delta^{34}\text{S}$  values indicate minor mobility. Assuming that the subadults represent the local signal of  $\delta^{34}\text{S}$  it is very likely that adults with enriched  $\delta^{34}\text{S}$  could have migrated to Münsingen at some point during their lives.

This study presents stable isotope values of one of the most important Late Iron Age burial sites in Central Europe. The presented data provide new insight into diet, migration and social stratification of the population from Münsingen.

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#### **A re-examination of maxillary shape variation and the attribution of Early Pleistocene fossils to the genus *Homo***

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The attribution of several Early Pleistocene fossils to the genus *Homo* is controversial. The taxonomic assignment of the Stw 53 cranium from Sterkfontein is disputed, and the inclusion of the AL 666-1 palate from Hadar in *Homo* has been questioned.

To address the taxonomic affinities of these specimens, an analysis of 3D geometric morphometric variation of the maxilla and palate was conducted. Stw 53 and AL 666-1 were compared with specimens conventionally attributed to early *Homo* (KNM-ER 1813, 1470, 62000; OH 24, 65), *Homo erectus*, and *Australopithecus*, as well as a modern extant sample.

Results indicate that AL 666-1 falls comfortably within the range of variation of specimens attributed to *Homo habilis* and *Homo rudolfensis*. The maxilla of Stw 53 falls just outside the expected range of variation of this early *Homo* group, but is clearly separate from the morphospace occupied by *Australopithecus*. Furthermore, Stw 53 demonstrates closest affinities to SK 847, a traditionally undisputed member of the genus *Homo* from South Africa.

While maxillary shape alone does not form the basis for taxonomic attribution, these results, taken in combination with previous discrete analyses, indicate that both AL 666-1 and Stw 53 can be accommodated within the variation observed in fossils traditionally attributed to early *Homo*, rather than *Australopithecus*.

#### **Structural variant discovery among related vervet monkeys**

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While differences in chromosome structure are likely a prominent source of genetic variation in non-human primates, relatively little has been achieved to assess the functional potential of structural variants in recently available primate genomes. We first built a high-quality genome reference for the vervet monkey (*Chlorocebus sabaues*). We then used this resource to discover deletions and inversions while characterizing these mutations as either germ-line or acquired. To do this, we selected a family unit (a male, a

female, and their three offspring) and normalized genome sequence coverage from each individual to approximately 10x. We next used overlapping split read and paired-end discordance coordinates to detect structural variants that measured between 100 base pairs (bp) and 1 megabase (Mb) in length. Among the family group, we identified 1,111 and 10 deletions and inversions, respectively, that were shared across each individual. We observed a large size range across the deletions (173 bp - 0.96 Mb), yet we found no de novo deletions in the offspring. The inversions were randomly dispersed across chromosomes and also represented a range of sizes (104 bp - 84,203 bp). A single offspring possessed a pair of inversions that were not detected in either parent or in either sibling, so we examined the intersection of these insertion coordinates with the vervet monkey gene coordinates. While no genic regions are directly impacted, we show how regulatory regions may be affected and illustrate the functional potential of structural variants to alter gene dosage or compromise cellular processes.

#### **Adaptation to milk consumption and evolution of lactase persistence in goat herders from Central-Northern Chile**

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Lactase persistence evolved with the development of milking pastoralism in the Old World as an adaptation to milk consumption in adults. The spread of this trait is one of the best examples of positive natural selection in humans. However, the specific mechanisms conferring selective advantages to lactase persistence are unknown.

Consumption of milk from other animals was introduced to the Americas during the last 500 years. To understand the evolutionary effects of this dietary adaptation, data about dietary and reproductive behaviour, DNA samples, and measurements of height and weight were collected during 10 months of fieldwork in pastoralist communities of admixed ancestry from Central-northern Chile.

Sequencing of the lactase gene enhancer region revealed the presence of the European variant of lactase persistence (-13,910\*T), in strong association (99.64%) with the phenotype of 41 participants as assessed using tests of lactose digestion. The frequency of lactase persistence in this population (0.38) is similar to what has been found in admixed populations in the Americas without pastoralist subsistence.

Controlling for ancestry, relatedness, and other variables, the association between lactase persistence and fertility, height and weight was evaluated, finding no significant effect of lactase persistence on fertility, but a significant effect of

## AAPA Abstracts

lactase persistence in BMI ( $p = 0.001$ ), and of BMI on fertility.

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**Tropical lianas: Correlations with habitat type and primate use at Brownsberg Nature Park, Suriname**

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Studies show that a dramatic increase in liana biomass in tropical forests is correlated with recent increases in atmospheric CO<sub>2</sub>. An increase in liana abundance may increase the diversity of food types, but high liana loads have a negative impact on tree survival. This study provides a baseline for assessment of liana density and primate habitat preference in a relatively undisturbed forest in the Guiana Shield. Data were collected at Brownsberg Nature Park Suriname from May to June, 2013, on aspects of tree size and canopy cover, and liana number and diameter in 163 10 x 10m plots. Liana biomass was calculated using established methods and combined with a concurrent primate survey of preferences for "plateau" or "slope" forest. Slope forest had a higher liana biomass (Pearson R = 0.17, P = 0.03, N = 163) and higher canopy cover (R = 0.17, P = 0.03). Five of the seven primate species (i.e. *Alouatta*, *Cebus*, *Sapajus*, *Chlorocebus*, and *Pithecia*) showed no preference for slope or plateau. Only *Ateles paniscus* expressed a preference for slope and higher canopy cover. *Saguinus midas* preferred plateau forest with lower canopy cover. Only *Alouatta macconnelli* was encountered in areas with high liana biomass (R = 0.16, P < 0.05), but the combined primate sample showed a trend toward a preference for high liana density (R = 0.14, P = 0.07). The effect of climate change on tropical forest primates is of great interest and increasing density of lianas may affect habitat preferences in complex ways.

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**Subadult mandibular morphology in an early medieval skeletal collection from Northern France compared with modern individuals of European ancestry**

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Dietary consistency has been shown to play a role in craniofacial development in animal models. To test this mastication hypothesis in humans, this study attempts to limit genetic contribution by studying two populations with European ancestry, from vastly different time periods and cultures. In this way, the primary focus is on environmental determinants of mandibular morphology. Here we explore subadult mandibular morphology from a bioarchaeological sample from Northern France (7<sup>th</sup> to the 11<sup>th</sup> centuries) compared to modern subadult individuals from the US. Twenty subadult skeletons from the early medieval sample are included, aged from 9 months to 10 years, and 18 years (sexes pooled). Three-dimensional coordinates are measured using a digital microscribe. The results are compared to the gonial angle, ramus height, and corpus length of subjects from the Bolton Growth Study from cephalograms of 24 male and 24 female modern European American subadults, 0.4 to 5 years and 16 years (Liu, 2009). The medieval mandibles have significantly smaller gonial angles. As a result, they are more robust than modern individuals during the first year of life (117.5° for the medieval sample compared to 129° for the modern). Gonial angle for the ancient sample ranges from 117.5° to 121.7°, whereas the gonial angle of the modern sample ranges from 126° to 129°. Although genetic variance cannot be completely ruled out, these significant differences appear in the earliest age group. Therefore, we conclude that dietary differences early in development contribute significantly to the secular change in mandibular morphology.

**Flexible responses of gorillas and chimpanzees to environmental disturbance: Implications of past and present logging**

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Great apes have a long evolutionary history of adjusting to fluctuating environments. However, basic questions remain as to how gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes troglodytes*) cope with modern environmental conditions—particularly those associated with anthropogenic disturbances such as mechanized logging. Most studies of apes and forestry have compared areas with different logging histories, rather than documenting the responses of a particular ape population to timber extraction as it occurs. We present the results of a before-, during- and after- logging study aimed at monitoring the temporal and spatial

distribution of sympatric gorillas and chimpanzees in an active forestry concession in northern Republic of Congo. During 12 repetitions of 14 transects (totaling 89 km per passage), we documented 6497 ape nests (2503 gorilla nests, 3994 chimpanzee nests) which comprised 1806 nest sites (852 gorilla sites, 954 chimpanzee sites). Both species of ape repeatedly shifted away from active forestry activities toward areas of lower human disturbance. Aspects of social spacing within species were also found to be influenced by environmental conditions across the land-use matrix over time. Our conclusion is that ape declines which occurred at small spatial scales were the result of ape redistribution into nearby "refuge areas", rather than the loss of individuals. These findings are examined in light of the logging company's adherence of Forest Stewardship Council certification standards and the compatibility of sustainable forestry with the conservation of African great apes.

**Examination of Primate Conservation Knowledge amongst College Students**

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In Northeast Ohio, there is a lack of knowledge regarding threats to biodiversity, especially among college students. Having a more knowledgeable community should mean students would be more willing to take action regarding conservation. The present study was conducted to evaluate Youngstown State University students' knowledge of non-human primates, including threats to them and conservation efforts to preserve them.

A 23 question survey was administered to two experimental groups (N=55) and one control group (N =23). The students represented a variety of different majors (31 in total) and all class levels. All three groups had class lectures by the professor (LRL) and a pre-test and a post-test was administered. The survey focused on knowledge of primates, threats to their survival and activities related to conservation. In addition, a student (JM and AS) presented 12 minute lecture focused on primate conservation was given to the experimental groups.

Post-test results between the experimental and control groups show significant differences regarding interest in conservation. Interest in conservation was 19% higher in the experimental groups after the student presentation on primate conservation, in contrast to the control group with only professor instruction. Also of interest is divided along college lines, data show STEM students were more knowledgeable but less interested in primate conservation, while non-

STEM students were less knowledgeable but more interested in the subject.

This study shows a need for a conservation General Education Course (GER) at the freshman level at Youngstown State University.

#### Dental topography and dietary ecology of the first North American euprimates

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The first North American euprimates, *Teilhardina brandti* and *Cantius torresi*, appear in the fossil record at the beginning of the Eocene, ~56 mya, likely as immigrants from Eurasia in the earliest Wasatchian North American Land Mammal Age (Wa-0). While primates known from Wa-0 do not overlap with each other in body size, qualitative similarities in tooth morphology of immigrant euprimates to endemic microsyopids ('stem primates') suggest the possibility of competition for dietary resources. We used microCT-generated 3D digital models of second lower molar crowns from contemporaneous Wa-0 primates (euprimates *Teilhardina* and *Cantius*, and microsyopids *Niptomomys* and *Arctodontomys*) to quantitatively assess dental topographic metrics (relief index, Dirichlet normal energy, and orientation patch count [OPC]) that differ by dietary category among extant primates. All metrics indicate omnivory that potentially emphasized fruit in the euprimates and *Niptomomys*. Relief index is highest for *Arctodontomys*, suggesting a diet emphasizing structural carbohydrates, and OPC is higher in the larger-bodied *Cantius* and *Arctodontomys* ( $p < 0.05$ , Kruskal-Wallis test) than in the smaller-bodied *Teilhardina* and *Niptomomys*. These data indicate larger-bodied Wa-0 primates emphasized different dietary components than did the smaller-bodied. No significant differences were detected between *Teilhardina* and *Niptomomys*, suggesting that despite non-overlapping body size ranges these taxa ingested food items with similar mechanical properties during Wa-0. We conclude that dental topography confirms the potential for resource competition between *Cantius* and *Arctodontomys* and *Teilhardina* and *Niptomomys* respectively. Ecological partitioning between these groups may be better reflected by differences in the anterior dentition, body size, activity patterns, or locomotion.

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#### Social bonds without genetic ties? A new framework for characterizing social relationships among female bonobos (*Pan paniscus*)

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Despite living in patrilineal social groups, unrelated female bonobos (*Pan paniscus*) exhibit high levels of gregariousness and gain several benefits from intra-sexual associations including female-biased sharing of preferred foods and coalitionary aid against male aggression. Previous studies have found little evidence for selective, stable social relationships or for reciprocal exchange of cooperative acts among females. These patterns may indicate weak social relationships in which benefits are gained through harassment, or alternatively females may have mechanisms to maintain diffuse, tolerant social relationships with a range of partners. We evaluated competing hypotheses to explain female social relationships and cooperation among bonobos at the Lui Kotale field site, DRC. Over two study periods separated by one year, we used continuous focal observations to measure patterns of intra-sexual association, affiliation and cooperation. We calculated individual indices of social engagement and partner diversity, as well as dyadic affiliation indices. We used GLMMs to examine whether patterns of food sharing were best predicted by dyadic bond strength, individual social engagement, reciprocal altruism or harassment. The majority of females had preferred social partners, but social preferences shifted across observation periods and were related to changes in reproductive state. Food sharing was best predicted by individual variation in social engagement. Females who were more socially engaged and responsive to social signals in other contexts were also more likely to share food with partners, regardless of their identity. We discuss the implications of these results for exploring the evolutionary origins of more flexible forms of cooperation in humans.

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#### SE Asian Parent/offspring trios offer insight into sex-specific patterns of DNA methylation at the leptin core promoter

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Anthropological Geneticists characterize the manner by which environmental factors affect gene expression, phenotypic plasticity and human adaptation. Dietary nutrients are ongoing determinants of gene expression, moderating the metabolic programming of a nutritional phenotype—an accumulation of interactive processes between inherited genotype, environmental factors and nutrition. Programming this phenotype begins *in utero*, resulting in individually unique patterns of metabolism, nutrient utilization, and gene expression. Epigenetic mechanisms, such as DNA methylation, also affect gene expression without altering DNA sequences, thus implying transient mediation influencing developmental plasticity by more rapid, flexible and reversible means than natural selection. Human DNA methylation studies suggest dietary effects on methylation patterns of the leptin (*LEP*) locus. Leptin is involved in regulation of energy homeostasis, adipogenesis and reproduction.

We previously examined DNA methylation patterns at the leptin core promoter in maternal/duos of four populations from three continents. Here we examine parent/offspring trios. Analyzing 14 SE Asian trios, with a total of 17 offspring (total n=45), we calculated correlations across seven *LEP* promoter CpG methylation sites among both parents and offspring. These seven sites exhibited varying methylation densities. One of the seven sites produced significant correlations between parents ( $r^2$  0.571) and between offspring ( $r^2$  .678) but no significant correlations occurred between fathers and sons or mothers and sons across the seven sites. Significant inverse correlations between mothers and daughters at sites 2-7 and fathers and daughters at sites 3 and 6 (all  $p < 0.005$ ,  $r^2 = -0.555$  to  $-0.740$ ) were seen, suggesting that methylation densities are lower in daughters.

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#### Are Tarsiers fast or slow? A comparison of the triceps surae muscle and muscle fibers

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The tarsier is a specialized leaper. The triceps surae (soleus and gastrocnemius) carry out plantar flexion. In many mammals, plantaris also assists in plantar flexion. Here we present gross anatomical and histo-anatomical data on the triceps surae and plantaris of *Tarsius syrichta*, with a comparison to *Galago*, *Varecia*, *Haplemur*, *Macaca*, and *Miopithecus*. Previous



## AAPA Abstracts

anatomical descriptions state that the tarsier has a large plantaris and a small/absent soleus. A large plantaris is the primitive mammalian condition. Our observations show that tarsier has the derived state, a small/absent plantaris. The tarsier plantaris has a thread like tendon and no observable muscle belly. When examining the relative mass of the triceps surae, the tarsier does not differ significantly from other primates examined (~.5% of total body mass). However, when relative gastrocnemius and soleus muscle weights are compared, leapers have relatively larger gastrocnemii and smaller solei. Typically the gastrocnemius is made up of mostly fast twitch (Type II) muscle fibers, which forcefully contract to produce explosive movements, but fatigue rapidly. Conversely, soleus contains mostly slow twitch fibers. This is the pattern observed in most primate sampled here. The tarsier presented with 72% Type II fibers in gastrocnemius, which is typical. However, the tarsier soleus shows a higher percent of Type II fibers, a pattern shared with *Haplemur*. Interestingly, when the knee is bent (e.g., like during vertically clinging and leaping), soleus does the majority of the work in plantar flexion. The larger gastrocnemius and more powerful soleus may be an adaptation for leaping.

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#### Metabolic and endocrine changes during immune activation

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Immunocompetence is an integral part of organismal life histories, and is involved in physiological trade-offs with other functions like growth. There remains a paucity of data on the actual energetic demands of human immune functions relative to other species. Here I provide a comparative analysis to qualify and quantify the energetic costs of immunity in humans, relying heavily on a series of studies documenting relative metabolic and endocrine changes during immune activation resulting from either naturally acquired infections or immunizations. Increased metabolic demands during immune activation appear to be met largely through the pleiotropic actions of various hormones, including testosterone, cortisol, thyroid hormones, estrogens, dehydroepiandrosterone, leptin, and oxytocin. Changes in hormones during immune activation reflect the manifold interactions between these physiological systems. A number of unanswered questions remain: for example, how do these hormones regulate sickness behavior; are there differential energetic costs of developing, activating, and redistributing immune responses; and how do metabolic costs of immune activation vary within and among people? Future analyses in human ecological immunology must include detailed effects of a variety of hormones in both men and women, utilizing various functional measures of immunity (e.g., bacteria

killing assay, hemolytic complement assay, lymphocyte proliferation, etc.) in a variety of experimental regimes: during health, in response to infections of varying severity, and in people experiencing varying degrees of energy flux. Trade-offs between immunity and other functions may only become apparent under certain conditions, or during particular critical windows at certain points in the life course.

#### Biological and environmental determinants of extinction risk: a comparative study of lemurs and marsupials

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In addition to external factors, such as environmental change, intrinsic traits render some species more extinction-prone than others. Several studies have attempted to isolate mechanisms underlying this pattern, such as body size, reproductive output, or thermoregulation. Fewer studies have examined the combined effects of species traits on extinction risk. In this paper, we examine the combined effects of several intrinsic species traits on extinction risk, and test whether the relative effects of different traits on extinction risk vary depending on habitat type. We focus on a comparison of patterns within two unrelated yet ecologically similar groups: lemurs (Cheirogaleidae, Madagascar) and marsupials (Dasyuridae, Australia). Furthermore, both Madagascar and Australia can be divided into a low rainfall, low-productivity arid zone, and a higher rainfall, higher-productivity mesic zone, allowing examination of whether biological correlates of extinction risk differ between broad environment types. We assembled a database of species occurrences, geographic coordinates, ecogeographic region, climate data, extinction-risk classification (IUCN ranking), body size, reproductive output, and thermoregulation for localities across Madagascar and Australia. These data were analyzed using phylogenetic models. Our results indicate that species classified at higher risk of extinction are non-random subsets of the continental fauna with respect to body size (larger), reproductive output (single births or small litters), and thermoregulation (no torpor). In other words, on each landmass, the reproductive output or thermoregulation effect was present only within the climatic zone most affected by human influence. This suggests that the mechanism underlying extinction risk differs depending on the type of environment.

#### Rendered "unfit": Impairment, disability and the children of the Erie County Poorhouse

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The Buffalo Plains Erie County Poorhouse (1851-1926) attempted to provide indoor relief for the destitute among the expanding populous of Western New York. In the latter part of the 19<sup>th</sup> century, charitable organizations began to question the benefits of this institutionalization on poor and destitute children. Among the concerns warranting reformation of policy were the continuing cycle of poverty, corruption of the body and soul, and lack of adequate education. The Children's Law of 1875 dictated that children between the ages of 3 and 16 would be removed from poorhouses across New York State. However, children labelled as idiotic, defective, deformed, and/or diseased were rendered unfit for society or familial care and remained inside of the poorhouse.

The skeletal remains of over 60 children were excavated from the Erie County Poorhouse and Hospital cemetery. Analysis of both the skeletal and documentary archives reveals that the majority of these children were infants who suffered from malnutrition and both acute and chronic diseases. However, a number of children between the ages of 3 and 16 are present among the cemetery remains. The passage of the Children's Law, coupled with the already common practice of separating healthy infants from their mothers and removing them from the poorhouse, complicates our analysis of the child human archive. The impacts of societal views on children's impairments are vital to our understanding of the mortuary context, demographics and pathologies of the skeletons from the poorhouse cemetery.

#### Robusticity in the axial skeleton: An example of the rib

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Skeletal robusticity, (total cross-sectional area relative to bone length) reflects the biological relationship between longitudinal growth and transverse expansion. Many have found robusticity to covary with several morphological traits (e.g., cortical area) and tissue-level properties (e.g., cortical tissue mineral density) throughout the appendicular skeleton. These traits play a critical role in determining whole bone stiffness and strength, a direct reflection of the bone's ability to functionally adapt to its loading environment. However, the relationship among traits has yet to be investigated in the axial skeleton. We used the rib to preliminarily explore how these traits associate among one another. Cross-sectional images from midshaft of ribs 4-6 from 40 individuals (9 females, 31



males) between 17-48 years of age were analyzed to obtain total area (Tt.Ar), cortical area (Ct.Ar) and section modulus (Z). Curve Length (Cr.Le) was used as a proxy for bone length in calculations of rib robusticity (Tt.Ar/Cr.Le). Preliminary results reveal significant ( $p < 0.01$ ), positive relationships between robusticity and Ct.Ar ( $R^2 = 0.172$ ),  $Z_{\text{PLEURAL}}$  ( $R^2 = 0.532$ ), and  $Z_{\text{CUTANEOUS}}$  ( $R^2 = 0.416$ ) that improve slightly with adjustment for age, but not body size. These results indicate that slender ribs have less bone tissue and less resistance to bending, as has been shown in long bones of the extremities, but may be affected differently by body size than appendicular bones. Regardless, robust bones have a consistent functional advantage over slender bones throughout the skeleton. Future analyses will incorporate whole bone bending stiffness and tissue-level properties as a possible source of functional compensation.

**Missing, presumed dead: Deconstructing 'high' infant mortality with new data sets from historic cemetery populations**

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It is a common assumption in physical anthropology that infant mortality must have been much higher in historic human populations than it is today; perhaps reaching 30-50% or more of total mortality. This hypothesis has not been tested, largely because of the lack of reliable demographic data before the Industrial Revolution. By turning to data sources which have never been compared before, it is possible to shed light on this complex problem as well as the most fundamental facets of historic lifeways. Over two hundred cemetery excavation reports from North America and the UK were appraised, of which seventy-two had suitable sample sizes ( $>10$ ) and demographic data to study ratios of adults ( $>18$  years), children (2-18 years), and infants ( $<2$  years). Eighteen North American cemeteries and all twenty-three British cemeteries employed sufficiently precise age estimation methods to research age-specific mortality in depth and to assess its similarity to standard attritional mortality as compared to Model West life tables. On average, infant and child mortality was lower in English cemeteries than in North American cemeteries (14% and 16%; 25% and 23% respectively). No relationship between mortality and climate could be found. There was a weak correlation between robust sample size and higher infant/child mortality, however a range of plausible mortalities existed within most smaller cemeteries. This suggests that population growth and thorough excavation will partially account for some higher early life mortality patterns, while infant mortality from an excavated assemblage in general may range from ~15-35%.

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**Early social exposure in wild chimpanzees: Mothers with sons are more gregarious than mothers with daughters**

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Early social experience has important consequences for behavior later in life. While mother-infant interactions are a critical aspect of early social experience, interactions with the broader social environment also influence infant outcomes. Mothers may facilitate or limit those interactions depending upon factors such as maternal rank and offspring sex. Indeed, studies in cercopithecines have demonstrated that mothers are more permissive when high-ranking and with males infants. Less is known about how these factors relate to infant socialization in fission-fusion species where subgroups are fluid and mothers may determine infant social exposure at a broader scale. In this study, we investigate whether maternal gregariousness varies by infant sex in wild chimpanzees (*Pan troglodytes*) at Gombe National Park. Using 38 years of long-term data on mothers that were observed with both sons and daughters, we found that mothers were significantly more gregarious with infant sons than with infant daughters ( $F_{1,1958} = 6.73$ ,  $p = 0.01$ ). Differences in gregariousness were most pronounced during early infancy ( $<6$  months:  $F_{1,465} = 10.33$ ,  $p = 0.001$ ) when maternal patterns are unlikely to be influenced by infant interactions with others. During this early period mothers with sons also spent significantly more time in parties containing adult males than did mothers with daughters ( $F_{1,465} = 12.63$ ,  $p = 0.0004$ ). The observed differences foreshadow adult behavior and suggest that mothers play a role in facilitating the development of sex-appropriate behavior by altering their association patterns. These results raise interesting questions regarding the evolutionary history of differential social exposure and its role in facilitating gender-typical human behavior.

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**Preliminary report on the acquisition of tool-using elements during termite gathering among chimpanzees of the Goulougo Triangle, Republic of Congo**

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The prevalence of tool-assisted foraging among chimpanzees suggests that acquiring these skills may improve dietary quality and potentially enhance reproductive success. Young chimpanzees develop tool-using proficiency over several years, and with various forms of social input. The aim of this study was to document the acquisition of complex tool-using skills among chimpanzees of the Goulougo Triangle, Republic of Congo. In addition to the termite fishing behavior observed in Western and Eastern African chimpanzee populations, central chimpanzees (*Pan troglodytes troglodytes*) use multiple types of tools to access termites in subterranean and epigeal nests. We hypothesized that the manufacture and use of tool sets would occur later than termite fishing. We also predicted sex differences in the acquisition of termite fishing skills, as has been documented in Gombe, Tanzania. Using a longitudinal approach, we scored 144 hours of remote video footage recorded during chimpanzee visitation to termite nests for critical elements in tool use. The minimum ages of acquisition of critical elements associated with termite fishing occurred within the range of those reported from Gombe chimpanzees, but elements associated with the use of tool sets occurred later. This may be due to the strength requirements, greater material selectivity, or more extensive tool modifications associated with these tool sets. Females displayed a higher frequency and greater diversity of critical elements than males. Our next step is to examine social influences on the maintenance of these complex tool traditions, which will aid in modeling the evolution of technology in early hominins.

**Maternal lineage of pre-Hispanic Mayans from the archeological sites "El Rey" and "Palenque"**

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The Mayan civilization was located in most of the region named Mesoamerica, in the territories of Guatemala, Belize, Honduras, El Salvador and

5 states of Mexico (Campeche, Chiapas, Quintana Roo, Tabasco y Yucatán). This civilization started in the Pre-Classic period (c. 2000 BC to AD 250) and had the maximum splendor during the Classic period (c. AD 250 to 900). The Mayan civilizations of the archeological sites "El Rey" (200 to 1200 C.E) and Palenque (200 to 900 CE) are very important to study their maternally lineage and relationship with other Mayan populations to understand their origin, migration, Population structure and kinship. Consequently, the objective of this study was to determine the maternal lineage of those populations, and haplotype diversity by sequencing the Hypervariable region I (HVR1) of the mitochondrial DNA. Our results shows that the samples from "El Rey" displays haplogroup C and the samples from Palenque displays haplogroups C and D. These Mayan sequences were also compared with sequences from the NCBI database of contemporary Mayan populations, showing the same maternal lineage. In addition there were also other sequences from Mayans that displayed a different haplogroup or subhaplogroup suggesting that Mayan populations pertain to the same culture but had different genetic origins.

**Gross versus net metabolic rate: Which should be used when determining the speed of the minimum cost of transport for human walking?**

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For human walking, the metabolic cost per distance travelled (cost of transport, COT) describes a 'U' shaped curve as a function of speed, with a minimum value around intermediate walking speeds. Thus, for a given walking task, the speed at which the minimum COT occurs (SPminCOT) is a critical variable in modeling the mobility strategies of early *Homo*. It is not uncommon for authors to calculate the SPminCOT from a net COT curve calculated after subtracting either resting or standing metabolic rate from the gross (actual) metabolic rate during locomotion. This is done as a means of partitioning the energy consumed into a maintenance fraction (cost of resting or standing) and a locomotor fraction (cost of moving in excess of the former fraction). Such a partitioning assumes that these fractions are independent and additive during walking. We argue that the metabolic energy used (primarily) for ion pumping, thermoregulation, and muscle contraction interact dynamically and distinctly during the three different physiological states of resting, standing, and walking, so neither resting nor standing metabolic rate represents a consistent subset of the total cost during walking. Using metabolic data from women comparable in size to those from hunter-gatherer populations,

we determined SPminCOT using gross COT and for net COTs calculated by subtracting 1, 1.5, and 2 times standing metabolic rate: SPminCOT decreased from the gross COT value (1.37 m/s) by 12%, 26% and 48% respectively. We conclude that meaningful predictions of optimal walking speeds for *Homo* must be based on gross metabolic rate.

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**Seasonality and Modern Human Foraging Behaviors in the MSA of Northwest Ethiopia**

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Ongoing paleoanthropological research in northwest Ethiopia along the Shinfa River, a tributary of the Blue Nile, has recovered evidence of riverine foraging by Middle Stone Age (MSA) populations. Surface collection and excavation along the ancient river channels has yielded MSA lithics in association with a substantial ichthyofauna, mollusks, reptiles, and mammals. The modern climate at Shinfa is highly seasonal, with brief, intense wet seasons and protracted, extremely arid dry seasons. High-energy, bankfull river flows during the wet season make exploitation of aquatic fauna prohibitive. However during the dry season, when evaporative processes reduce the river to a series of waterholes, modern populations living nearby can effectively exploit the river's resources. Preliminary isotopic data suggests that a seasonal environment may have also existed during the Late Pleistocene when MSA people occupied the area. Stable carbon and oxygen isotope values recovered from isolated spot sampling of fossil bovid enamel (n=13) indicate that this sample was dominated by C4 feeders whose crowns formed, at least partially, in a warm, arid environment. In addition, serial sampling along the growth axis of the tooth was undertaken on both fossil (n=5) and extant (n=3) bovinds from Shinfa. Serial sampling revealed  $\delta^{18}\text{O}$  values and sinusoidal patterns of intratooth variation that are consistent with a shift from wet to dry seasonal environments during crown formation. We hypothesize that, similar to populations living in the Shinfa area today, MSA people occupying the area were best able to exploit available riverine resources during dryer climatic periods.

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**Tarsiers are real head turners: Morphologies related to extreme axial rotation in the cervical vertebral column**

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Tarsiers routinely position their heads in 180 degrees of axial rotation from the natural, forward facing position. Such an extreme degree of rotation, however, requires unique morphologies that enable an increased range of axial rotation of the cervical vertebral column. One functionally relevant feature previously described qualitatively in tarsiers is the presence of cervical zygapophyseal articular facets that are oriented more parallel relative to the vertebral body. However, this morphology has never been quantified, nor has it been compared against similar morphologies in a phylogenetically broad sample of primates. The purpose of this study is to fill this gap in knowledge by assessing articular facet orientation in the cervical spine by using 3D coordinate landmarks. Articular facet angle was measured from planes calculated from landmarks captured along the margins of the right superior articular facet and cranial surface of the vertebral body. We compare tarsier morphology to 25 taxa across primates (n=217) using phylogenetic least squares analyses.

Our results demonstrate that tarsiers exhibit relatively parallel facets at all cervical levels (C3-C7) and confirm previous qualitative descriptions in the literature. Furthermore, when tarsiers are removed from the primate-wide sample, a significant positive correlation between body size and facet angle is present at many cervical levels (C4, C6, and C7), suggesting that larger-bodied primates have more parallel facets when compared to their smaller counterparts. As tarsiers are relatively small-bodied, this result further highlights the specialized shape of tarsier cervical vertebrae.

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**Human Sacrifice in the Late Prehistoric American Bottom: Skeletal and Archaeological Evidence**

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Evidence for human sacrifice in the American Bottom is best known from Mound 72 at the Cahokia Mounds. Evidence for ritualized sacrifice includes the careful placement in 4 features of numerous young women in rows and layers, and in a 5th feature, the presence of both men and women, some with evidence of violent death. In one additional feature, four adult males were placed with linked elbows and heads and hands cut off, argues for a violent and ritualized death and burial.

Investigations conducted by Illinois State Archaeological Survey researchers at the East St. Louis Mound Center 7km from Cahokia indicate a clear association between sacrificial (or offertory) burials and human elements (e.g., crania) and the removal of large freestanding community posts. In contrast to Mound 72, these sacrificial burials occur only as a single interment located either directly over or within one of the entrance/exit ramps of the post pit.

Although the scale and context of human sacrifice vary between Cahokia and East St. Louis we argue that the appearance of dedicatory offerings such as human sacrifice coincides with the dramatic rise or 'Big Bang' of the Cahokia polity in the early Mississippian period in the American Bottom. Although large marker posts were often a component of community settlements prior to the Mississippian period, the sudden appearance of human sacrifice at this critical juncture of time clearly reflects the rapidly changing ideology and worldviews of the Mississippian people as they negotiate a new world.

#### 20 years of research on Asia's slow and slender lorises – patterns, processes and conservation priorities

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Asia's slow (*Nycticebus*) and slender (*Loris*) lorises make up one of the most fascinating primate radiations, yet until the 1990s, virtually nothing was known about their behaviour in the wild. I review data from my 20 years of fieldwork, including long-term studies in India, Sri Lanka, Cambodia, Thailand, and Indonesia. I show that lorises have relatively large home ranges averaging 12 ha (range= 2-32). Despite similarity in home ranges, no patterns occur in number of sleeping sites used by lorises ( $x=7$ , range 3-47), yet all species sleep in groups of a male and female and 1-3 offspring; this uni-male uni-female social grouping is complemented by promiscuous mating systems. In the wild and captivity, lorises are not seasonal breeders, and can give birth to one litter per year, with average gestation lengths of 165-170 days (*Loris*) and 192-203 days (*Nycticebus*), making their breeding patterns incredibly slow for such small-bodied primates. Lorises exhibit extreme dietary specialisations, with slender lorises being on

average 97% insectivorous (5 studies), and *Nycticebus* being on average 66% exudativorous (8 studies). Lorises also show high tolerance to foods containing secondary compounds – insects (*Loris*) and exudates (*Nycticebus*). *Loris* is one of few primates to exhibit anting behaviour, whereas *Nycticebus* is the only primate known to be venomous. Despite these fascinating adaptations all species of slow and slender loris are threatened on the IUCN Red List and urgent action is required to understand this lineage more fully.

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#### Ancient DNA sequencing of a Middle Woodland variant: a discussion of the Ray Site and recent findings

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Studies of unusual or anomalous examples frequently encourage new perspectives, placing the "normal" in a broader context. This is our motivation for studying the Ray site, a Middle Woodland burial located on a steep, narrow ridge near the confluence of the Illinois and La Moine Rivers. The Ray site is anomalous, when compared to other Middle Woodland sites, in that the cemetery is not mounded. In addition, the skeletons show an unusual, high frequency of pathology, including developmental conditions. Therefore, genetic relationships within the community that buried at the Ray site and between that community and their regional contemporaries are of interest. For this pilot project, we have extracted ancient DNA from a sample of teeth recovered from six individuals buried different in areas of the site. Using novel ancient DNA methods and a broad selection of ancestry and identity markers we evaluated signatures of gene flow and admixture, as well as biological relationship within the site. The panel of markers includes an array of autosomal single nucleotide polymorphisms (SNP) and maternal and paternal markers. Here we present initial results of this genetic analysis and discuss future directions for genetic analysis for the remaining 112 individuals of the Ray Site. This study also serves to complement ongoing studies of inherited skeletal and dental features.

#### Time, residential stability, and gender-specific growth changes in orphaned Jamaican children

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Considerable anthropological and epidemiological research has explored the physical, social, and cognitive development of children living in institutional care settings, as compared to their peers living with kin. However, less is known about the capacity for children to improve their health status over time while remaining in an institutional care setting. This study re-visited 70 children living in children's homes in Manchester Parish, Jamaica. It investigates the potential for changes in anthropometric assessments of study participants' growth and development over time, despite continued residence in children's homes. Study participants were initially interviewed and various anthropometric measurements were gathered in 2011, and these measurements were collected again in 2013. Repeated measures ANOVA analyses reveal no significant changes in z-score values of body mass index, and height for age in girls or boys regardless of age, or place of residence. However, girls did experience significant improvements in summed skinfold measurements and upper arm measurements. These results support earlier findings that orphaned Jamaican girls living in institutional care settings were healthier than their male counterparts, and suggests that they were able to continue on a pathway to positive health outcomes, unlike their male counterparts. This research contributes to cross-cultural anthropological studies of children's health, and the impact of variability in care-taking strategies on the physical growth and development of children.

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#### Does early-life environment cause differences in costs of reproduction in a preindustrial human population?

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Studies testing the trade-off between reproduction and survival in humans show variable results with both inter- and intra-population variation. One of the potential factors which could modify the trade-off between reproductive effort and survival is early-life environment. Early-life environment can have effects on health and body condition through changes in body structure, physiology and metabolism, and as a consequence may have an impact on resource acquisition. However, the relationship between variation in early-life environmental conditions and costs of reproduction has yet to be tested thus far in humans.



## AAPA Abstracts

The aim of this study was to quantify the effect of early developmental conditions on the trade-off between reproduction and survival. We predicted that women born in poor early-life conditions would show stronger trade-off between reproduction and survival compared to women who were born in better conditions. Moreover, we expected the effect to be stronger in women from poor socio-economic class.

We analysed individual-based life-history data collected from Finnish church records on women born between 1751 and 1850. We used historical records of annual crop yields, spring temperature and infant mortality in one's birth parish to assess the early developmental conditions of each individual.

We found that early-life environment around time of birth did not modify the relationship between reproduction and survival in preindustrial women.

Our results did not provide evidence that early-life conditions modify the relationship between reproduction and survival. More research is needed to help explain differences in costs of reproduction observed among populations and cohorts in the same population.

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#### The magnitude of covariation among regions of the human cranium

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The study of morphological integration characterizes the pattern and magnitude of morphological trait covariance. The magnitude of integration may influence evolution in that high integration may constrain the direction of morphological change, thereby maintaining correlated evolution of morphological traits, whereas weak integration may enable mosaic evolution. However, many studies of cranial integration describe the magnitude of integration as "high" or "low," but there is no standard for how these terms are defined.

In order to assess whether the face and dentition of humans are highly integrated, it is necessary to establish a baseline of "high" and "low" integration within the human cranium. We hypothesized that regions of the cranium that are spatially, functionally or developmentally related (e.g., the upper and lower face) would exhibit higher integration than regions that are more functionally and developmentally distinct (e.g.,

the occipital and lower face). 3D cranial and dental landmarks were acquired from CT scans of adult human crania (n=35) and analyzed using partial least squares analysis. Covariation among the upper face, lower face, occipital bone and dentition was quantified using the RV coefficient, a measure of the strength of multivariate integration. In agreement with the hypothesis, the highest magnitude of integration was between the upper and lower face while the occipital and face displayed lower, non-significant RV coefficients. Based on this baseline, the lower face and dentition are highly integrated structures. Broader application of this approach can provide context for the evaluation of the magnitudes of integration among regions of a single structure.

#### Quantification of the position of the flexor fibularis groove of the euarchontan talus

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On the talus, the position of the groove for the tendon of the flexor fibularis muscle, a plantarflexor of the foot and flexor of the digits, has been used to differentiate strepsirrhine and haplorhine primates. Extant strepsirrhines, which more frequently employ abducted foot postures, have a laterally shifted flexor fibularis groove (FFG). Among haplorhines, the FFG is situated beneath the talar trochlea (and thus more medially). While FFG position has often been qualitatively described, it has not been quantified, nor has it been well documented among other euarchontans (dermopterans, scandentians, and plesiadapiforms). Using measurements from microCT-generated surfaces from a comprehensive sample of extant and fossil euarchontans, we compare the position of the FFG. Landmarks were placed along the lateral rim of the trochlea and used to generate a reference axis. Additional landmarks were placed on the posterior medial and lateral margins of the FFG. Each talus was rotated so the line intersecting the FFG landmarks obtained the highest possible apparent deviation from orthogonality with the lateral rim axis. Linear measures from the margins of the FFG to the lateral rim axis were used to construct a ratio of lateral skew. Results confirm previously recognized differences in FFG placement between extant strepsirrhines and haplorhines. Adapiforms have laterally positioned grooves, while omomyiforms and fossil anthropoids have medially positioned grooves. However, subfossil lemurs have medially positioned grooves, violating the strepsirrhine/haplorhine dichotomy. Additionally, plesiadapiforms, dermopterans and ptilocercid treeshrews have laterally positioned grooves, suggesting to us that the "strepsirrhine" condition is primitive for euarchontans.

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#### Human nasal floor shape variation and its relationship to the anterior dentition

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Nasal floor shape variation in *Homo* has been putatively linked to several causative factors, though the high frequency of nasal floor depression in Neandertals, in particular, remains unexplained. Recent studies have suggested that variation in premaxillary growth dynamics related to the development of the permanent anterior dentition may be a possible explanatory factor. This project tested a series of hypotheses regarding the relationship between nasal floor shape and the size, and the timing of eruption of the anterior dentition. Since prior research had indicated that nasal floor depression corresponds with a vertically expanded premaxillary region, and that nasal floor depression also develops at a critical time in early permanent incisor development, vertical height of the anterior dentition (especially tooth root length) and dental developmental rate (i.e., precocious, normal, delayed) were examined as potential correlates. The sample for this project consisted of CT scans of subadult extant humans from clinical (IRB-01 200903778) and museum sources. Nasal floor shape variation was quantified using a sliding semi-landmark curve along the length of the nasal floor. Using the CT scans, incisors were measured (n=50) and dental developmental rate was estimated (n=30). We found no correlation between tooth root length and nasal floor depression ( $\rho=0.0872$ ;  $p=0.4682$ ). However, nasal floor depression was associated with precocious development of the permanent dentition (Kruskal-Wallis  $p=0.0389$ ). Although our sample sizes are small, and consist of cross-sectional rather than longitudinal growth data, these results nonetheless provide an explicit avenue for future research regarding patterns of nasal floor variation in *Homo*.

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#### Group Specific Alleles and Ascertainment Bias in Genomic Diversity Sets

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It is well established that genes can be used to predict ancestry, but in order for ancestry to accurately predict genotype there must exist high frequency, ancestry, or group, specific alleles (GSAs). The purpose of the research presented here is twofold; first we test whether commonly used race groups contain GSAs or if ancestry groups predicted by serial founder effects might be more informative. Our second goal was to identify biases related to GSA identification that occur when researchers merge databases to increase sample size.

We queried ~500,000 SNP loci across 31 populations in the CEPH-HGDP dataset for GSAs. Our results show that while 1,022 African and 9 American GSAs were identified, no other biogeographic region contained GSAs. Yet, when evolutionary lineages were predicted by SFE, it proved a more useful construct for identifying GSAs; we found 387 GSAs unique to a Non African group. These results indicate that using race groups as a proxy for populations is not sufficient to capture unique, high frequency variation. In this light, health scientists interested in using ancestry to predict genotype will be more successful with true evolutionary lineages rather than race groups. These results are consistent with data from an original program written to perform coalescent simulations on both microsatellite and SNP data.

We next compared the identified GSAs to a subset of loci sequenced in all individuals of the HAPMAP sample. When this subset was considered, all GSAs had been omitted, indicating an ascertainment bias favoring common variation.

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#### **High altitude adaptation and adaptive introgression in humans**

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I will discuss recent progress in my group on understanding the genetic basis of altitude adaptation in Tibetans and other humans. In Tibetans we (and other groups) have shown that important altitude adaptations relating to hemoglobin production are caused by mutations in the EPAS1 and EGLN1 gene. Recently we have also shown that the adaptive EPAS1 haplotype was transferred into humans by introgression from Denisovans. I will discuss recent progress on understanding the process of adaptive introgression in humans and its role in altitude adaptation.

#### **Comparison of aDNA yields from calculus and tooth roots in pre-Columbian skeletal remains**

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In recent years, dental calculus has emerged as an important source of ancient genetic material. However, calculus has not been extensively utilized as a source of endogenous host DNA when working with human skeletal remains. In this study we compare endogenous DNA yields obtained from extractions performed from both dental calculus and dental tooth roots for three pre-Columbian individuals, originating from three different archaeological sites of the island of Puerto Rico. Furthermore, in order to assess the effects of physical decontamination procedures on recovery of endogenous DNA, tooth root samples were further subdivided into two groups: one group was treated by removal of the cementum and the second group was left untreated. Extractions were then performed in three replicates for each individual, one from calculus, one from treated tooth roots and one from untreated tooth roots. DNA extracts were quantified, transformed into sequencing libraries, and enriched for the complete mitochondrial genome through in-solution hybridization capture. Preliminary results indicate that out of nine extracts obtained (three replicates for each individual) only seven were successfully built into libraries. Sequence data suggest that libraries made from treated tooth root extracts contain, on average, more sequence reads mapping to the reference and higher coverage than libraries built from untreated tooth root or calculus extracts. These results suggest that although calculus is a viable source of endogenous DNA, treated tooth root extractions result in higher overall endogenous DNA yields and a reduced presence of contaminant DNA molecules in these samples.

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#### **Testing the cylindrical model for weight reconstruction - the effects of fat mass, lean mass, and body proportions**

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The stature/bi-iliac breadth method (Ruff et al., 2005) provides reasonably precise body weight estimations for a broad range of human

populations because this method is based on the cylindrical model of human body in which stature and bi-iliac breadth represent the cylinder height and breadth, respectively (Ruff 1994. *Yrbk Phys Anthropol* 37:65-107). Relative shoulder breadth (biacromial breadth / bi-iliac breadth) and the proportion of trunk length to limb length (represented by relative sitting height) have potential effects on estimation precision. Previous studies (Ruff 2000; Ruff et al., 2005) indicated that relative shoulder breadth has a significant effect on prediction error, but relative sitting height has only a slight effect. In this study, we test the effects of both body proportions, as well as lean body mass and fat mass (computed from skinfolds) on estimation precision using a large sample of Finnish males and females measured by the first author. We found that, in both sexes, relative sitting height has a significant effect on prediction error, but relative shoulder breadth is insignificant; lean mass (scaled against stature) has the most effect on prediction error, but fat mass (also scaled against stature) also affects prediction error more than body proportions in both sexes.

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#### **Helium experiment and vocal physiology of the phoe calls in common marmosets**

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Whistle-like high-pitched phoe calls are often used as long-distance vocal advertisements by small-bodied marmosets and tamarins in the dense forests of South America. While the source-filter theory proposes that vibration of the vocal fold is modified independently from the resonance of the supralaryngeal vocal tract (SVT) in human speech, a rigid source-filter interaction that constrains the vibration frequency to the SVT resonance effectively produces loud tonal sounds in some musical instruments. Here, we used a combined approach of acoustic analyses and simulation with helium-modulated voices to show that phoe calls are produced principally with the same mechanism as in human speech. The spectral power of the  $f_0$  was amplified distinctively from the upper harmonics in normal conditions. Although the  $f_0$  shifted up slightly in the helium-enriched conditions, its shift was considerably less than that expected for formants influenced by increased helium concentrations. By contrast, the  $f_0-2f_0$  intensity difference was greatly and monotonically decreased by an increase in the helium concentration. The animal keeps the fundamental frequency ( $f_0$ ) close to the first formant ( $F_1$ ) of the SVT, to amplify  $f_0$ . Although  $f_0$  and  $F_1$  are primarily independent, the degree of

their tuning can be strengthened further by a flexible source-filter interaction, the variable strength of which depends upon the cross-sectional area of the laryngeal cavity. The results highlight the evolutionary antiquity and universality of the source-filter model in primates, but the study also allowed us to explore the diversification of vocal physiology in non-human primates.

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#### Can we refine body mass estimations based on femoral head breadth?

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Femoral head breadth (FHB) is widely used in body mass (BM) estimation in biological anthropology. Our earlier study (Ruff et al., 2012) demonstrated that reduced major axis (RMA) equation performs better than least squares (LS) equation. However, experiments with our pan-European Late Pleistocene and Holocene dataset (BM is represented by estimates provided by stature / bi-iliac breadth method of Ruff et al., 2012) as well as with the W. M. Bass Donated Skeletal Collection data demonstrate that BM of small individuals are still slightly overestimated and those of large ones underestimated. Including stature (estimated from skeletal height or even from long bone lengths) in an equation reduces this directional bias somewhat, but this improved prediction precision is noticeably only at extremes of size variation. A simple RMA-equation to estimate body size from FHB based on a large reference data is thus sufficient in most cases.

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#### Utilizing community interviews to develop a comprehensive species list at the Tonkolili Chimpanzee Project in Sierra Leone

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The Tonkolili Chimpanzee Project—a recently developed conservation site in Sierra Leone—required a comprehensive list of all known fauna in order to create an ecological map of the region. Our methods for developing this species list included reliability testing and informal interviews with randomly selected members of the local community, and proved to be an efficient and effective means of obtaining reliable ecological data for the region. Community members of varying ages and genders (n=10) were asked to participate in the survey. In order to determine whether a given species was “present” or “not present” at the site, we used an iPad© tablet, along with an African wildlife guide application that contained photos and descriptions of each species. Participant dependability was verified through reliability testing measures—we inserted “ruse” species that were known to be absent from the region randomly throughout the questionnaire. In order for the participants’ results to be considered, they had to identify the ruse species as “not present” 100% of the time. The survey successfully produced a species catalogue of the mammals, birds, and reptiles within the habitat. For example, the results indicated, in addition to chimpanzees, the presence of 10 other primate species, 3 carnivores, and 7 ungulates, among others. The survey was conducted as part of the Tonkolili Chimpanzee Project initiative, which seeks to study and conserve chimpanzees living in an anthropogenic habitat consisting of a riparian forest fragment surrounded by croplands and villages.

#### Sex-linked stable isotope patterns in a Kenyan population of olive baboons (*Papio anubis*)

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Evolutionary anthropologists use stable isotope signatures to infer many aspects of the behavioral ecology of species. For example, carbon and oxygen isotopes have been used as evidence of weaning and dispersal patterns. Here we examine individuals of *Papio anubis* from the Neil Tappen Collection (University of Minnesota) to determine if males (n=16) and females (n= 18) record similar oxygen and carbon isotope signatures in their molars.

The difference between male (-0.36‰) and female (-0.21‰) mean oxygen isotope ratios was not significant (p=0.6). This suggests that the males in the population, who leave their natal troops at adulthood, did not disperse widely, as both male and female juveniles had access to

water sources with the same isotopic composition.

Significant differences in oxygen isotope composition between the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> molars were found in females (M1:M2 p=0.02, M1:M3 p=0.05) but not males (M1:M2 p=0.5, M1:M3 p=0.9). In neither sex did the results reflect expected oxygen isotope patterns along the tooth row; oxygen isotopes should become less enriched in <sup>18</sup>O from M1 to M3 due to weaning as breast milk is enriched in <sup>18</sup>O compared to drinking water.

Enrichment of <sup>13</sup>C from M1 to M3 in females was opposite that of males. Female M1s (-7.54‰, n=3) were enriched in <sup>13</sup>C compared to M3s (-10.02‰, n=6), while male M1s (-9.86‰, n=7) were depleted in <sup>13</sup>C compared to M3s (-7.06‰, n=4). This may reflect different weaning behaviors between the sexes, ontogenetic changes in diet composition, or changes in vegetation structure during each individual’s growth.

#### Development of culturally relevant measures of stress and social support among Mexican immigrant families

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Many researchers who investigate racial disparities in cardiometabolic diseases assume that underlying genetic differences must be the cause. However, these studies are often limited by the absence of culturally-relevant measures of stress. Development of relevant stress scales is particularly important for US Hispanic populations, who experience a disproportionate burden of stressors as both immigrants and minorities, and a high rate of cardiometabolic diseases, which may result from these exposures. Straightforward translation of existing stress questionnaires into Spanish can produce imprecise or inaccurate responses. In this study, a culturally-relevant questionnaire was adapted from previously validated surveys, including the Hispanic Immigrant Stress survey, to assess stress and sources of social support among Mexican immigrants in Nashville, TN. Ten focus groups were conducted with Mexican women (n=36) at an immigrant-serving organization using a semi-structured moderator guide. Focus group discussions centered around questions including, “What does the word ‘stress’ mean to you?” and “What makes life easier or more difficult here for you and for your children compared to in Mexico?” After transcription and translation, the data were coded by two independent investigators using NVivo 10.0. Prominent themes included stressors related to discrimination, employment, homesickness, language barriers, and sacrifice. One key finding is that the concept ‘estres’ is not commonly used in Mexico. These results informed the development of a culturally-relevant

questionnaire to assess stress among Mexican immigrant women and children. This questionnaire can be used in future analyses to determine if immigrant-related stressors are associated with precursors of cardiometabolic diseases in children.

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### **The Importance of Multi-Ethnic Genetic Studies: the Population Architecture using Genomics and Epidemiology (PAGE) Study**

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Genomic studies in individuals of European ancestry have identified loci associated with several cardiometabolic traits (CMT). As efforts continue to unravel the genetic underpinnings of disease, there is a need for better representation of ethnically diverse populations who are disproportionately impacted by complex diseases and have unique patterns of genetic variation related to human disease. The Population Architecture Using Genomics in Epidemiology (PAGE) consortium provides an optimal opportunity to investigate the association of genetic variants with complex diseases in ancestrally diverse populations. We typed the Metabochip, a high-density array developed to capture known genetic variants for CMT phenotypes that also includes variants polymorphic in any 1,000 Genomes project population, so that ancestral diversity is captured. Our analyses included 35,000 African Americans (AA), 26,000 Hispanics (HA), 17,000 Asians, and 18,000 European Americans (EA). We assessed associations for lipid and obesity phenotypes, assuming an additive model, adjusting for age, sex, and population structure and then used a fixed-effects meta-analysis to combine within and across race/ethnic groups. We identified novel signals for BMI in non-EA, for example *KCNQ1* rs2237897 ( $p < 5 \times 10^{-8}$ ). We also detected associations for several well replicated SNPs, for example with BMI for rs543874 near *SEC16B* (AA and HA,  $p < 5 \times 10^{-5}$ ). Signals with distinct independent lead SNPs were also identified, for example with HDL-C for *CETP* (rs247617 in HA, rs183130 in AA,  $p < 5 \times 10^{-5}$ ). Our study emphasizes the importance of leveraging differences in linkage disequilibrium patterns among populations to identify new susceptibility variants, refine association boundaries, and prioritize SNPs for functional evaluation.

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### **Skin, hair, and iris pigmentation: quantifying phenotype and identifying genetic loci associated with variation in diverse populations**

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Characterizing skin, hair, and iris pigmentation and understanding the genetic architecture underlying this phenotype is of interest to the fields of anthropology, evolutionary biology, and forensic science. Compared to European populations, we know little about patterns of variation in non-European and admixed populations or the genetic variants that contribute to this diversity. Here we describe quantitative estimates of pigmentation in large samples of European, East Asian, South Asian, Hispanic, and African American ancestry. Skin and hair pigmentation were measured as M (melanin) index using a DSM II reflectometer. Iris pigmentation was quantitatively assessed from digital photographs and translated into CIELAB color space using novel methods. We observe significant variation among populations in skin ( $F = 543.8$ ,  $p < 0.0001$ ) and hair ( $F = 164.6$ ,  $p < 0.0001$ ). Mean skin pigmentation is lightest in Europeans ( $M = 35.4$ ,  $SD = 3.1$ ) and East Asians ( $M = 38.0$ ,  $SD = 2.9$ ), while South Asians ( $M = 47.5$ ,  $SD = 6.1$ ) and the admixed African American ( $M = 64.6$ ,  $SD = 11.9$ ) and Hispanic ( $M = 41.6$ ,  $SD = 7.5$ ) populations are darker and more variable. Analysis of a subset of samples indicates that variation in iris color, including in East and South Asian irides (categorically described as "brown"), can be quantitatively described using CIELAB values. We argue that this refinement in phenotype characterization will increase our power to detect genetic loci with small effects and highlight as examples loci identified as influencing skin and iris pigmentation in East Asians.

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### **Child health in the early medieval community from Omeý Island, western Ireland**

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Children were always the most vulnerable part of a human society. They are susceptible to various forms of metabolic stress that may leave a permanent record on bones and teeth and as such are excellent indicators of health. The aim of this paper is to investigate the frequency and distribution of cribra orbitalia (CO) and linear enamel hypoplasia (LEH) in children and adults, and periostitis in children from the early medieval (7th-10th c. AD) site of Omeý Island in western Ireland. A possible case of clavicular

ante-mortem trauma in an infant from this rural community is also discussed.

The total analysed sample consists of 43 subadults and 75 adults (40 females and 35 males). The CO frequency in adults is 33.3% (25/75) with a slightly higher frequency in males, while in children it was observed in 50% (14/28) of cases. LEH was observed in 65.0% (26/40) of studied individuals, and in 40.4% (101/250) of anterior teeth. The age ranges of LEH formation vary between 2.5 and 4.9 years for all anterior teeth combined. Periostitis was recorded in six subadults, and in three cases it was generalised active inflammation suggesting systemic infections. One infant (1-2 months old) exhibits ante-mortem healed fracture of the left clavicle, an injury mostly associated with complicated births.

The results of this study strongly suggest that most of the individuals from Omeý Island suffered from severe physiological disturbances during their childhood caused by a synergistic relationship between infectious diseases, inadequate nutrition, and poor sanitary conditions.

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### **The effect of social factors on body length proportions in Polish schoolchildren from Lower Silesia**

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Many studies have shown that in Poland social factors significantly affected the growth of children in height. However, very few researchers studied influence of social factors on body length proportions. The aim of the present study was assessment of an effect of urbanization level, sibship size and parental education on body length proportions in schoolchildren.

325 boys and 335 girls aged 7-18 years were measured in schools in Wrocław (city about 640 000 inhabitants), two small towns (below 50 000 inhabitants) and rural area around towns. Height, sitting height, leg length (B-tro), and lower leg length (B-ti) were measured in all children, then relative lengths (in relation to height) were calculated: leg, femur (B-tro-B-ti), lower leg, estimated leg (B-v-BS-v), and femur-to-lower leg ratio. Height were standardized on age using LMS parameters for CDC 2002 year cohort. Other indexes were standardized on age by using residuals variance derived from linear regressions. Four-way analysis of variance was used for height and each index, where independent variables were four social factors.



None of the social factors had significant effect on height. Urbanization level significantly differed all indexes, whereas only father's education level significantly affected relative length of lower legs (B-ti).

Surprisingly, the segments of lower limb are much more sensitive to influence of social factors than height. In Lower Silesia, the level of urbanization is still related to differences in environmental conditions, enough to significantly affect growth of children, especially the segments of lower limbs.

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**Offspring of Primiparous Mothers Do Not Experience Higher Mortality or Poorer Growth: Revisiting the Conventional Wisdom with Archival Records of Rhesus Macaques (*Macaca mulatta*)**

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Female mammals may begin to reproduce before achieving somatic maturity and therefore face tradeoffs between allocating energy to reproduction or their own continued development. Constraints on primiparous females are associated with greater reproductive failure, and first-born infants often have slower growth and higher mortality and morbidity than infants born to multiparous females. Effects of early life investment may persist even after weaning when juveniles are no longer dependent on maternal care and mother's milk. We investigated the long-term consequences of differential maternal investment for both first-born and later-born offspring in a large sample of *Macaca mulatta* assigned to the outdoor breeding colony at the California National Primate Research Centre (N=2724). A joint model for growth and mortality over the first three years of life allowed us to explicitly connect growth rates to the likelihood of survival. As expected, males are born heavier and grow faster than females. However, contrary to expectations, later-born males face substantially lower survival probability during their first three years, whereas first-born males survive at higher rates similar to both first-born and later-born females. Compensating effects of physiological and behavioral adaptations in first-born offspring and their mothers, as well as the novel ecology of the captive environment, may explain these findings. Whatever the underlying causes, our results encourage us to consider how offspring calibrate

and organize themselves in response to maternal investment strategies.

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**Dissection and Social Inequality: the Bioarchaeology of Structural Violence**

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Structural violence is harm done to individuals or groups through the normalization of inequalities that are deeply, and invisibly, embedded in political economic organization. Fundamentally there are two ways in which bioarchaeologists can approach the study of structural violence. First, research may focus on the lived experiences of individuals or groups and the resulting health disparities. This is based on the premise that socially derived differences in access to and control over resources can have physiological consequences that can result in skeletal manifestations. Alternatively, bioarchaeologists may focus on reconstructing the structural violence of 'death experiences'. While the dead body is no longer an experiencing body, the dead can retain an active agency and continued social significance. If we are to consider how social inequality becomes embodied as disparities in health, then we must also consider how the experience of social inequalities may result in 'disembodiment' and the fragmentation of the body. Using previously published data, as well as new data on evidence of dissection, I will discuss the structural violence of the 19<sup>th</sup> century almshouse in the United States from both of these perspectives. While the health consequences of institutionalization are well documented, I will demonstrate how the reformation of poor relief and the adoption of anatomy laws that legalized dissection of the almshouse inmates became intertwined and how this reflects the structural vulnerability for poor and socially marginalized groups.

**Behavioral flexibility in orangutans: How sociality is modulated at different levels by fruit availability, demographics, and life history in a wild population on Borneo**

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Orangutans are considered unique among apes in terms of their low level of sociality. Originally characterized as solitary, orangutan researchers have revised this designation over time and now typically classify orangutans as semi-solitary with individual based fission-fusion dynamics. Over the course of a year-long study at Gunung Palung National Park on Borneo, 60% of

orangutan follows included social events. Many of these involved actively gregarious or affiliative behaviors, suggesting benefits for social grouping for orangutans beyond simply aggregating at food sources or for mating opportunities. Different age-sex classes engaged in different types of social behavior and displayed different patterns in social partner choice, indicating shifting benefits of sociality through different life history stages. Adolescent females were the most social age-sex class, involved in 69% of all social encounters while mothers with dependent offspring were involved in only 19% of social encounters. Flanged males were present for 31% of social events, and unflanged males were involved in 20%. We discuss behavioral flexibility in orangutans as a result of unpredictable food availability in Southeast Asian rainforests along with the demographic and life history factors that modulate social behavior. This study provides a more nuanced picture of orangutan sociality by examining both the ecological context in which social encounters take place and the factors that influence the social behavior of individuals, allowing for a more thorough understanding of the variation in sociality that is observed between orangutan populations.

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**Can cephalometrics discriminate between the sexes in a diverse juvenile sample?**

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Sex estimation is a critical component of the biological profile; however, methods commonly used to estimate sex in adults do not work for juveniles. The ability to reliably estimate sex in juvenile remains would allow for more complete demographic studies and aid in identification of unknown individuals. There is a wealth of literature devoted to juvenile sex determination using sexually dimorphic regions of the skeleton in adults (pelvis, skull and teeth). Some morphological studies have demonstrated a discriminatory power over 80%. Replication of these methods has been difficult, making the methods unreliable. Population-specific studies have used cephalometrics from individuals with normal occlusion to estimate juvenile sex with 80 to 90% accuracy. Our study attempts to estimate sex in individuals less than 18 years of age using a sample of 562 lateral cephalograms incorporating all three Angle Class occlusions and ethnic and racial diversity. Twenty-two cephalometrics were found to have significant differences between the sexes but only four did



not involve soft tissue or have small sample sizes. The significant cephalometrics are: the distance from the Nasion-Point B (orthodontic landmark) line to the tip of the lower central incisor, overjet, Condylion to Gonion and Condylion to Gnathion. Using discriminant function with those four variables males were correctly classified 79% of the time; however, it misclassifies females 61% of the time. As a result, our study does not support the use of cephalometrics to sex juveniles who are diverse ethnically, racially and in regards to their Angle occlusion classification.

#### **A comparison of *Pan paniscus* and *Pan troglodytes* perikymata distribution in upper incisors and lower canines by crown length and height**

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*Pan paniscus* and *Pan troglodytes* diverged 2-2.5mya; behavioral, morphological, and life history similarities and differences exist between the species. The species appear to have similar dental development in tooth crown and root formation timing. However, based on a single *Pan paniscus* upper incisor, it has been suggested that the species' distribution of perikymata may differ. This research compares perikymata distribution between *P. paniscus* and *P. troglodytes* anterior teeth, using 21 lower canines, 11 first upper incisors, and 7 second upper incisors. Perikymata XYZ coordinates were recorded with a measuring microscope and VisionGauge software. Crown height (vertical extent of the crown) and lengths (total length of the curve of the crown) were calculated for each tooth to establish deciles. The number of perikymata per decile and number of perikymata per millimeter per decile were recorded for both crown height and length measurements on teeth that were either unworn or had minimal wear. The SAS PROC MIXED program was used to evaluate perikymata distribution for the two species and three tooth types. Crown height and length measurements produced statistically similar results. Statistically distinct perikymata distribution patterns between the species were found for all tooth types. The number of perikymata per millimeter per decile was found to be consistently lower in *P. troglodytes* than *P. paniscus*; profilometry images confirm this absolute difference in perikymata density. These data suggest that although *Pan troglodytes* and *Pan paniscus* have similar schedules of dental development, more subtle enamel growth differences have evolved since these species diverged.

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#### **Statistical evaluation of cortical thickness maps of the humeral diaphysis: A comparison of techniques**

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The aim of cortical thickness mapping is to visualise spatial variation in the thickness of cortical bone throughout a specimen. The technique also provides a means of statistically comparing the cortical properties of different individuals. Cortical mapping is becoming more prevalent in the literature as an aid in assessing morphological differences in long bones that may be ascribed to habitual behavioural differences or to genetic divergence. It has also been used in the medical literature to assess bone loss through osteoporosis.

At present, four forms of size standardisation and superimposition of the maps are popular for inter-individual comparisons: Fourier transform; Procrustes superposition; statistical parametric mapping and iterative closest point. All apart from the last operate directly on the raw measurements, whereas ICP relies upon a pre-generated 3d mesh of the periosteal and endosteal surfaces, which are deformed to a standard model. After superposition the residual variation between individuals can be analysed using PCA or Discriminant Functions.

Cortical thickness maps were generated for the 20-80% of length margins of the diaphysis from a large sample (N>100) of juvenile and mature modern human humeri and analysed using all four techniques. We establish that one can potentially track the development of muscular attachments along the bone, using this technique. We discuss how using the different standardisation processes can alter our conclusions as to group affinities, with implications for methodological selection when examining fossil remains.

#### **Rank and reproductive state as predictors of female faunivory in Kasekela chimpanzees**

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Pregnancy and lactation are costly. Females' strategies to manage those costs include dietary shifts across reproductive states. Chimpanzees (*Pan troglodytes*) are ripe-fruit specialists, and

dietary quality (measured by the proportion of fruit vs. other plant foods in the diet) positively correlates with rank. Rank in turn is a significant predictor of reproductive success. However, chimpanzees in many populations also consume insects and/or vertebrates. Animals are generally energy- and nutrient-dense relative to plants and may provide critical macronutrients, minerals, and vitamins otherwise limited in chimpanzees' diet. No published studies have examined patterns of chimpanzee faunivory during pregnancy and lactation.

Using 38 years of data on the Kasekela community, we assessed the influence of rank and reproductive status on the proportion of foraging time spent in faunivory. Using GLMMs, we tested whether (a) females treat animal foods as high-quality resources [predicting that high-ranking females consumed relatively more fauna than lower-ranking females], and (b) faunivory varies by reproductive state [predicting that pregnant females or those in early lactation (infant <24mo) consumed more fauna relative to 'baseline' females].

We found a significant interaction between rank and reproductive state for meat-eating ( $p=0.010$ ). High-ranking females spent relatively more foraging time consuming meat regardless of reproductive status. Lower-ranking females increased meat consumption during pregnancy. We found no relationships between rank/reproductive status and insectivory. This pattern likely reflects the greater potential energy/nutrient intake rate of meat vs. insects. Our findings suggest that faunivory may be of particular importance to reproductive females, with consequences for infant development and survival.

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#### **Intra-specific variability in anterior and post-canine dentition in *Paranthropus robustus***

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The relationship between dietary adaptation and craniofacial variation in hominin morphology is not always clear. For *Paranthropus*, it is generally accepted that an increase in post-canine dentition size was selected for concomitant with chewing musculature for a specialized diet, but it is unknown how this selection affected intra-specific variability in dental size and shape. Here, we propose that *Paranthropus robustus* is characterized by statistically significantly more intra-specific variability within anterior dentition

compared to posterior dentition, reflecting the influence of selective pressures on post-canine teeth.

To test the variability of *P. robustus* dentition in size and shape, occlusal surface outlines on >120 maxillary and mandibular anterior and post-canine teeth were traced by Elliptical Fourier Functional Analysis (EFFA) and subsequently analysed with MLmetrics software. EFFA is a method that has been applied to hominin mandibular morphology and other species' dentition, but it has not been widely used to analyze hominin dental shape and size. Here, we conduct analyses between individual teeth as well as across dental regions.

Preliminary results suggest that there is statistically less variability within the post-canine dentition compared to that characterizing anterior teeth. Given that variability in tooth shape and size is often invoked in taxonomic identifications, it is important to recognize that selection for dietary adaptations may influence intra-specific dental variability in different regions in the mouth. Future studies will include comparisons between *P. robustus* and other hominins and primates to determine if this pattern is specific to paranthropines, or characterizes closely related species regardless of dietary adaptations.

#### **Chimpanzee skeletal muscle fibers are not super strong**

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Since the 1920s and perhaps earlier, it has been reported that chimpanzees differ from humans in being capable of exceptional feats of strength, both in the wild and in captive environments. A mix of anecdotal and more controlled studies has suggested that the strength of a chimpanzee exceeds that of a human by five or more times. Hypotheses for the source of the purported 'super-strength' of chimpanzees have included higher isometric force-generating capabilities and/or faster maximum shortening velocities than human skeletal muscle.

To test these hypotheses, isolated fibers were sampled from the *m. vastus lateralis* and *m. gastrocnemius lateralis* of three common chimpanzees (*Pan troglodytes*). Maximum isometric force and maximum shortening velocity were measured at 15°C using an isolated muscle fiber preparation. SDS-PAGE was then used to determine the myosin heavy chain (MHC) content of each fiber.

The maximum isometric force of chimpanzee skeletal muscle range from 9.6 to 15 N cm<sup>-2</sup> and maximum shortening velocities range from 0.5 to 5.1 L s<sup>-1</sup>, depending on MHC type. These results are well within the range of previous studies of humans and other terrestrial mammals. Our data demonstrate that chimpanzee skeletal muscle fibers are not superior to humans in force-generating capabilities or maximum shortening velocities. Rather, chimpanzee and human fibers appear to be quite similar in their contractile properties. These results suggest that skeletal muscle contractile properties have been conserved throughout the past 6 to 8 million years of hominin evolution.

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#### **Thermal changes in the people of Herculaneum**

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Excavations in the early 1980s unearthed skeletal remains from the town of Herculaneum, Italy, which was affected by a series of pyroclastic surges when Mount Vesuvius erupted in AD 79. Temperature estimates for this event have typically ranged between 400°C and 900°C. This study was conducted on the remains of the people who fled to the beach and boathouses during the eruption; it includes a total of 149 individuals. For 94 of them we studied the crania and post-crania. For 51 individuals only the skulls were studied and for 4 individuals only the post-crania were available. Data collection focused on determining the maximum temperature exhibited on the bone following standard thermal alteration procedures, which use bone color and fracture patterns to estimate temperature.

The results indicate patterning that is inconsistent with people exposed to high heat for an extended period of time. Tissue shielding played a major role in the burn patterns observed and it is clear that soft tissues were present for some time after thermal exposure. Juveniles often reached higher temperatures than adults. Of the adults known to have perished on the beach, most were heavily charred, corresponding to temperatures around 300°C. Calcined bone was rare, but was found on adult tibia and crania as well as several juvenile crania, indicating the highest temperatures reached by the bone exceeded 600°C and may have reached 900°C. Our findings indicate that surge temperature estimates near the high end of the 400°-900°C range are more appropriate.

#### **Walking for warmth: a reassessment of Neanderthal locomotor inefficiency**

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Neanderthals have large body masses and reduced lower limb lengths, which reduced body surface area to the cold, and have been proposed to be cold-climate adaptations. However, these cold climate adaptations have been suggested to reduce Neanderthal locomotor efficiency - increasing the metabolic cost to walk and run. This increased locomotor cost is one reason Neanderthals had higher total energy expenditures (TEE) than modern humans. Here, I demonstrate that among highly active modern humans living in natural environments, higher activity costs help to mitigate thermoregulatory costs in cold climates. Heat produced during activity can be used in place of heat produced through thermoregulatory processes to maintain a constant body temperature in cold conditions, and reduce overall thermoregulatory costs. Thermoregulatory costs were estimated among a group of healthy adults (N=30) participating in National Outdoor Leadership School semester long courses in two ways: potential thermoregulatory costs with the addition of heat produced from activity and potential thermoregulatory costs without the addition heat produced from activity. Thermoregulatory costs estimated without heat from activity were 29% higher than estimated costs, which included activity (p<0.0001), suggesting that activity produced heat helps reduce thermoregulatory costs in cold conditions. Using the Allocation Model, which estimates basal metabolic rate, thermoregulation, activity, and thermic effect of food costs and using relevant data from the literature, I reassess Neanderthal energetics. I contend that the high level and cost of Neanderthal activity could have effectively negated additional thermoregulatory costs, and perhaps even reduced selective pressure for greater locomotor efficiency.

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#### **Violence and conflict in prehistoric northwest Mexico**

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Paquimé, also known as Casas Grandes, was one of the largest and most complex societies in prehistoric northwest Mexico, with established trade networks and social influences from Mesoamerica, the American Southwest, and western Mexico. Analyses of the human skeletal remains from Paquimé have found evidence for interpersonal violence, human sacrifice, and cannibalism during the Medio period (ca. 1200-

1450 AD), which coincides with increasing sociopolitical complexity, population aggregation and emerging social differentiation at the site.

In this study, we use strontium isotope analysis to explore the nature of conflict at Paquimé, namely, whether the victims of violence were members of the local community or outsiders, such as immigrants or captives. AMS radiocarbon dating was also conducted on a subset of the human skeletal remains to elucidate temporal patterns in migration and violence. Fisher's Exact, ANOVA, and Kruskal-Wallis tests were performed to examine potential associations between  $^{87}\text{Sr}/^{86}\text{Sr}$  values and trauma, mortuary treatment, post-mortem processing, age, and sex. The only statistically significant relationship found was between strontium isotope values and sex, as nine of the eleven individuals who exhibited non-local  $^{87}\text{Sr}/^{86}\text{Sr}$  signatures were male. Radiocarbon dates indicate that migration to Paquimé and violence at the site occurred throughout the Medio period. These initial findings suggest that birthplace was not a key factor in conflict at Paquimé because both locals and non-locals were among the victims of violence.

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#### Establishing the orientation and biobehavioural implications of the semicircular canals of *Cercopithecoides haasgati*

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The semicircular canal system of vertebrates is pivotal in the maintenance of visual stability and coordination of the body during movement. Prior research on primates has indicated that both canal size and deviations from orthogonality between respective canals (90Var) are linked to species agility, providing a potential means of predicting fossil species locomotor behaviours. The discovery of a well-preserved left temporal bone (HGT 200) of *Cercopithecoides haasgati* from Haasgat (>1.95 Ma, South Africa) has allowed for the first study of the semicircular canals in the species to assess patterns of mobility and, potentially adaptive differences to the larger-bodied *Cercopithecoides williamsi*. Semicircular canal morphology was extracted from microCT (fossil *C. haasgati*, *C. williamsi* and *P. angusticeps*) and high-resolution medical CT datasets (extant *Colobus* and *Papio*). In addition to established methods, we present and discuss novel methods for calculating canal

radius of curvature and 90Var. Our results indicate higher intraspecific variation in semicircular canal morphology than has been generally presented in past studies of higher-order relationships of morphology and behaviour; suggesting caution when assessing results from small sample sizes, particularly in studies with limited taxonomic diversity. Ultimately, the *C. haasgati* specimen did not exhibit differences in either metric when compared to *C. williamsi* or extant *Colobus*; however, the specimen does differ from *C. williamsi* in more specific morphological characteristics including lateral canal size. While this may indicate locomotor differences between the two colobines, larger sample sizes (than initially predicted) are required to understand the functional significance of this variation in canal morphology.

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#### Spirited away: Coevolution with HepB/HepC to explain the alcoholic flusher paradox

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The ADH1B\*2 allele metabolizes ethanol 100 times more rapidly than the ancestral allele, whereas the ALDH2\*2 allele fails to metabolize nausea-inducing acetaldehyde intermediates resulting in the "flush response". Individuals with or without ADH1B\*2 with at least one copy of ALDH2\*2 are less likely to become alcohol-dependent. These protective genes are frequent in East Asia and SE China and rare elsewhere in spite of adaptive benefits. In 1978, China became more receptive to the West and alcohol consumption has dramatically increased producing more alcoholics including paradoxical alcoholic "flushers", not yet explained.

Anthropological genetics best accounts for these "anomalies". 1) Chinese archaeology indicates a long history of ingesting fermented products within high density settlements associated with rice agriculture; status stratification induces stress perhaps relieved by alcohol used medicinally. 2) Alcohol consumption coevolved with hepatitis B and C viruses by synergistically enhancing replication and growth of the viruses within affected individuals, while damaging sperm and eggs of the host. 3) Alcohol-protective mutations that discouraged drinking were selectively favored where hepatitis B and C viruses common. Co-evolutionary pressures led to more virulent hepatitis favoring rapid increase of protective mutations. 4) The recent ready access to alcohol by the new Chinese middle class creates more opportunities for chronic drinking, possibly exacerbated by the stressors of Western cultural influence. 5) Excess alcohol consumption results in changes in DNA and histone methylation, histone acetylation, and micro-RNA expression (epigenetics) such that

individuals lose control of drinking behavior and gain tolerance—helping to create alcoholic flushers.

#### The systematic status of *Bunopithecus sericus*, a Pleistocene gibbon from Chongqing Province, southern China

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Fossil gibbons are known from several sites in China, dating from the early Pliocene onwards. Although gibbons were widely distributed across southern China in the Pleistocene, today they are restricted to Yunnan, Guangxi and Tibet in southwestern China and to Hainan Island. The best-known fossil gibbon from the Chinese Pleistocene is a left mandibular fragment with  $M_{2,3}$  (AMNH-18534) from Yanjinggou, Chongqing Province. Matthew and Granger described this specimen in 1923 as a new genus and species, *Bunopithecus sericus*. Establishing the age of the specimen has proved difficult because the fossil collections from Yanjinggou represent mixed faunas of different ages, but it probably dates to the early or middle Pleistocene. Subsequent opinions about its taxonomic status have been divided, with different authorities attributing it to extant *Nomascus* or *Hoolock*, or retaining it in its own genus, *Bunopithecus*. We reexamined the dental affinities and relationships of AMNH-18534, comparing it with 289 extant gibbon molars using size and shape variables. The comparative sample included representatives of the four currently recognized hylobatid genera. Our multivariate analyses demonstrate that AMNH-18534 is not attributable to *Nomascus*, but support for an exclusive affinity with modern hoolocks is equivocal. In most analyses AMNH-18534 does not cluster with any extant taxon and falls outside the range of variation for modern hylobatids, but its distance from the cluster represented by extant hoolocks is relatively small. The evidence indicates that *Bunopithecus*, retained here as a distinct genus, most likely represents a crown hylobatid that is possibly the sister taxon of *Hoolock*.

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#### The Influence of Fighting Ability and Reproduction in Intersexual Relationships in Verreaux's Sifaka (*Propithecus verreauxi*)

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The base of power in dyadic relationships can be difficult to isolate. Investigating the ontogeny of power may untangle how dominance and leverage shape intersexual relationships, especially in “female-dominant” species. Our goal was to test the alternative hypotheses that direction of agonism in intersexual dyads is predicted by (1) differences in fighting ability (i.e. dominance), or (2) females reaching reproductive maturity (i.e. leverage). Behavior and morphometric data were collected from 2007-2012 from 23 adults and subadults from 4 social groups of Verreaux’s sifaka (*Propithecus verreauxi*) in Kirindy Mitea National Park. Contrary to the hypothesis that female power is based on dominance, dyadic differences in body mass and canine size did not significantly predict submission or aggression: smaller females elicited unidirectional submissive signals from, and directed aggression towards, adult males. Consistent with the leverage hypothesis, age significantly predicted submission: adult females received 100% of submissive signals from males, whereas subadult females emitted 97%. While male-to-female aggression was not predicted by age, a trend existed for adult females to initiate aggression towards males more frequently than subadult females. The ontogeny of intersexual power in sifaka reflects changes in reproductive abilities rather than differences in size, suggesting that intersexual power in sifaka is based on leverage rather than dominance. Interestingly, female leverage seems to be based on the ability to produce offspring rather than mating opportunities because subadult female sifaka can sometimes be sexually active. Moreover, our results suggest that leverage effects may be more important in determining intersexual power than fighting ability.

#### Juvenile growth and socioecological correlates in a wild colobine

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Primate growth patterns have been shown to respond flexibly to socioecological variation on both ultimate and proximate scales, the latter of which makes growth rate a potential proxy for fitness variation in pre-reproductive individuals. Yet concurrent size and behavioral data of non-adults from wild populations are scarce, therefore, our current understanding of growth patterns is based largely on captive datasets. Here we present limb growth curve estimations for Phayre’s leaf monkeys (*Trachypithecus phayrei crepusculus*) at the Phu Khieo Wildlife Sanctuary in northeastern Thailand. Between November 2006 and May 2008, we photographed individuals from three habituated groups and collected corresponding laser-measured distances-to-subject. Following photogrammetric methods, we determined knee-to-heel length for 51 individuals (19 males, 32

females), including 35 of known age and four with age estimated from known birth season. We employed cubic spline regression to fit growth and pseudo-velocity curves to the mixed longitudinal and cross-sectional dataset, and calculated size-for-age residuals from separate male and female cubic polynomial regressions. We found that juvenile males grew at slightly faster rates than females to attain larger adult length, though adult length dimorphism was very mild (1.07). Limb length was a significant positive predictor of feeding intake rates among juveniles and sub-adults. Despite the potential disadvantage of small size to feeding efficiency, we found no evidence of longer lactation periods for small-for-age juveniles ( $p > 0.05$ ,  $n = 11$ ), suggesting that, despite a mechanically demanding diet, mothers did not invest longer to supplement small offspring during the transition to nutritional independence.

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#### Manual proportions in *Australopithecus*: A comparative analysis including new material from Sterkfontein

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Previous analyses have shown that *Australopithecus africanus* possessed more ape-like limb length proportions than *Au. afarensis*. Together with morphological features linked to arboreality, these proportions led some researchers to hypothesize that arboreality was a more significant component of the locomotor behavior of *Au. africanus* relative to *Au. afarensis*. Furthermore, some recent analyses suggest that manual proportions in *Au. afarensis* were fully human-like, while others indicate that they were not as human-like as previously described. Analyses of *Au. africanus* metacarpal proportions suggest thumb proportions are more ape-like in breadth, though more human-like in length, and similar to *Au. afarensis*. The hand proportions of *Au. sediba* have been described as being very similar to those of modern humans. In order to better characterize the morphology of *Au. africanus* and examine interspecific differences in the genus *Australopithecus*, this study presents a comparative analysis of metacarpals and phalanges from Sterkfontein, including undescribed fossils.

Osteometric data were collected on manual rays of *Au. africanus*, *Au. afarensis*, *Au. sediba*, and from a comparative sample of modern humans and extant great apes. Multivariate and bivariate analyses were used to assess shape variation

within elements (e.g., proximal phalanges, individual metacarpals), and sampling approaches were used to examine metacarpal-phalanx and relative thumb proportions across taxa. Preliminary analyses suggest that *Au. africanus* may be more human-like in some aspects of hand morphology than *Au. afarensis*, especially in metacarpal proportions, which contradicts the locomotor hypotheses based on limb-size proportions for the two taxa.

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#### Primate research and challenges to meaningful engagement in Côte d’Ivoire’s Tai National Park

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Since its inception in 1989, the Tai Monkey Project (TMP) has engaged communities in southwestern Côte d’Ivoire around Tai National Park through employment (field assistants, botanists, camp caretakers), public health (e.g., condom distribution), and educational and research support for Ivoirians. We maintain strong economic and personal ties with local villages; however, our relationships have been challenged at times.

Land use conflicts remain the most serious threat to the TMP’s relationship with neighboring villages. This is exemplified by the Wild Chimpanzee Foundation’s attempts to purchase and reforest farmland to enhance corridors for chimpanzee populations. The response has been significant anger and frustration from locals, many of whom don’t distinguish between research projects operating within the forest. Similarly villagers reacting to dropping commodity prices, economic migrants, and population increases are replacing the forest’s buffer zone with plantations.

Ongoing political unrest has complicated interpersonal dynamics. Endemic ethnicities around Tai were on the “losing” side in the contested 2010 election and palpable tensions between locals and migrants from the north remain. Current TMP employees resent hiring of non-locals or other ethnic groups; consequently, long-term hiring practices have both purposefully and inadvertently followed ethnic lines, limiting opportunities for emigrants.

While poaching has declined in research areas, it remains problematic at forest peripheries.

Despite strong messages from our field assistants, some local villagers continue to target bushmeat. The looming specter of Ebola shows that consequences extend beyond non-human primate populations: TMP and residents around Tai will be significantly challenged by this approaching humanitarian crisis.

#### Forensic Classification and Biodistance in the 21st Century: Why the Machines Will Win

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Traditional classification methods such as linear and quadratic discriminant function analysis are one-step methods with statistical assumptions that can limit their applicability. Small samples are difficult to analyze. Machine Learning (ML) methods rely on computers and extensive bootstrapping (sampling with replacement) and have fewer assumptions. ML has grown tremendously in the last ten years as software has advanced. Boosting and bagging are recent methods that use multiple (possibly poor) classifiers (an ensemble) to generate an optimal classifier. The newest ML methods can combine quite disparate data types and involve ensembles of ensembles, including Missing Features, which handles missing data by randomly subsetting variables rather than through multiple imputation.

While classification methods have the goal of maximum accuracy, calculating biological distances involves objectively estimating intergroup relationships. ML can analyze various combinations of molecular and morphological data and provide explicit confidence intervals for classification accuracies and biological distances. Further, ML has few assumptions, can perform better stepwise (subset) selection, and can avoid problems with traditional classification methods such as overfitting, which restricts the number of variables used.

Using craniometrics from the Forensic Data Bank, traditional four-way classification of American white and black males and females is usually 80 to 85% accurate. Several ML methods classified over 900 individuals from the same groups with over 95% accuracy. Even higher accuracies were accomplished through choosing from over 4,000 non-traditional interlandmark distances, which are especially useful with fragmentary remains.

In short, the machines will win because the machines *have* won. They earned it.

#### Maternal and paternal population history of Indigenous individuals in British Columbia

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Reconstructing Native American population history in the Prince Rupert Harbour region of British Columbia, Canada, is made possible by the presence of numerous ancient individuals that have been unearthed at several archaeological sites. We examined mitochondrial (maternal) and Y-chromosome (paternal) DNA from seven of those sites and from three modern tribal groups in the region. We found several haplogroup A Hypervariable Sequence 1 (HVS1) haplotypes shared among the sites, but no haplogroup D or X haplotypes. Additionally, no Y-chromosome haplotypes were shared. We compared the ancient haplotypes to their presumed descendant populations (the modern groups) and found that several haplogroup A HVS1 haplotypes and one haplogroup X haplotype were shared. In analyzing the genetic diversity of the modern individuals compared with the ancient individuals, we see a greater reduction in genetic diversity in the paternal DNA than in the maternal DNA. This pattern has been found in other studies and could be attributed to sex-biased survival, meaning more non-Native than Native Y-chromosomes in the modern individuals survived owing to admixture with European males after European contact.

#### Two feet from the same individual from the Middle Pleistocene site of Sima de los Huesos

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In the Sima de los Huesos Middle Pleistocene site more than 6500 human fossils have been recovered to date. They represent a minimum of 28 individuals and have been considered ancestors of Neandertals. All skeletal elements are represented in the Sima de los Huesos sample, and more than 500 specimens belong to the foot. Here we present the analysis of two nearly complete feet (Foot 1 & Foot 2) from within the collection. They are comprised of 23 tarsal and metatarsal bones that belonged to a fully adult, probably male, individual.

Morphologically, this individual displays robust and broad feet. Moreover, both feet show broad lateral talar malleolar surfaces, broad calcanei, stout naviculars and robust metatarsals.

These two feet are indistinguishable from those of modern humans in the implied locomotor capabilities and similar in overall size and proportions. However, the robusticity and some metrical traits help us to differentiate them from modern human populations. Based on regression equations of modern humans, a stature of around 173-174 cm has been calculated for this individual. The chronology of around of 430 ka for the site, and the results of this study make this association the oldest robust modern-like feet in the genus *Homo*.

*We are deeply grateful to SH-team and to many people who allowed access to skeletal collections. This research is funded by CGL2012-38434-C03-01 and AGAUR 2014-SGR-899 projects and European social fund.*

#### Malocclusion and cranial modification: assessing maxillary occlusal variation in artificially modified crania

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The human skull is a complex structure composed of independent but closely integrated functional units. Within this context, cranial modification, the cultural practice of intentionally altering the shape of the cranial vault through the application of external pressures, is often considered a natural experiment testing the relationship between neurocranial, basicranial, facial, and mandibular growth. Though it is generally accepted that changes in the cranial vault produce changes in the rest of the skull, little work has been done examining the effects of cranial modification on occlusion. As such, this study explores possible associations between cranial modification and the occlusal variables of crowding, displacement, and rotation within an archaeological sample of 64 individuals from the Peruvian southern highlands. Sites included in this study all date to the Imperial Inca period (1400-1532 CE) and are located in the Cusco region.

Results reveal that neither annular nor tabular forms of cranial modification were associated with the occlusal variables of crowding or displacement. However, cranial modification was associated with rotation, with over half of tabular skulls examined exhibiting rotation. These findings suggest that the cascading effects of cranial modification may have also affected certain aspects of the occlusion of the maxillary dentition, and that the dentition may be more closely integrated into the cranial functional matrix than previously thought.

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#### **A Synthesis of Archaeological and Mitochondrial Genome Data at the Eva Site**

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Since the publication of the detailed Eva site reported by Lewis and Lewis in 1961, the Eva site in Western Tennessee has played a fundamental role in understanding Archaic traditions in the Midsouth U.S. region. Both the site's wealth of material culture and skeletal remains have enabled archaeologists and bioanthropologists to characterize the cultural traditions and populations of the Shell Mound Archaic. Due to recent advances in non-destructive DNA extraction methods, we accessed mtDNA data from the molars of nine individuals from the site's earliest stratum. The success of this non-destructive technique allows for unprecedented access to the genetic profile of the Eva site's oldest occupants, which had previously been limited to estimates of population relatedness to other archaeological populations based on phenotype alone. Mitochondrial data were generated by targeting portions of HVI and HVII using traditional (Sanger) sequencing methods and by targeting complete genomes via next-generation techniques. This research presents the oldest mitochondrial DNA data from skeletons in the Southeast U.S. region and applies these results to theories for Peopling of the Americas and prevailing migration models. Through the combination of archaeological data with the data produced here, we present mitochondrial haplotype data to contextualize the genetic variation at the Eva site within the broader geographic landscape of both archaeological and genetic variation in the Southeast.

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#### **Scars of Alabama: Bioarchaeology of Violence among Riverine Islanders**

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The route taken by Hernando de Soto through the American Southeast has never been fully resolved. It has been proposed that de Soto made contact with villages on islands in the Tennessee River of Alabama in 1540. Pine Island is the proposed home of the Coste, while the more

southern McKee Island may have been home to the Tali. It was hypothesized that evidence of osseous trauma due to European weaponry would support contact with the Spanish expedition. Given the congruency of environmental conditions, evidence of any violent trauma should be equivalent in frequency and severity between the sites. Human skeletal remains from village sites on McKee Island (1MS32) and Pine Island (1MS100) were analyzed. Material evidence dates the majority of each skeletal assemblage to the 16<sup>th</sup> – 18<sup>th</sup> centuries. Adult skeletal remains of McKee Island had a significantly higher frequency of evidence of physical trauma, though at Pine Island there were more unequivocal examples of trauma due to warfare, and the people were more likely to die of physical trauma, as evidenced by significantly higher frequency of perimortem trauma or pathogenic infection associated with violent trauma. These results may be explained by differential intragroup conflict resolution, or a protected status that McKee Island enjoyed as a colony or subject of the regionally dominant Coosa, while the more autonomous Pine Island village may have been either target or instigator of conflict with neighbors. This study demonstrates the utility and importance of bioarchaeological comparison between environmentally congruent, contemporaneously inhabited sites.

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#### **Bargaining before birth: Pregnant women show motivational calibration in response to the size of their anticipated alloparental network**

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Humans are cooperative breeders and thus should be sensitive to how much social support they receive as parents. Females in particular should show calibration of stress mechanisms, such as the HPA, and psychological mechanisms related to parenting motivation. Hagen (2002) proposed that postpartum depression may be a bargaining strategy designed to extract greater investment from alloparents, and depression has been shown to reduce indicators of parenting motivation. This study examines pregnant women's social networks as future parenting resources as they relate to physiological stress and depression.

We hypothesized that quantity of alloparents would predict cortisol profiles and depressive symptoms. Specifically, we expected that as the number of potential alloparents increases, the

lower the baseline cortisol, the higher the diurnal rhythm, and the lower the depression score on the Edinburgh Depression Scale.

Five pregnant women in their third trimester were recruited from a midwifery firm in California. Participants completed a survey on life stressors, and the breadth and quality of their social relationships. Participants also gave nine saliva samples (three a day, over three days) which were assayed for cortisol.

Neither baseline cortisol nor diurnal rhythms were related to number of potential alloparents. However, depression scores were higher among women with sample-typical alloparent networks (2 to 5 alloparents) than among women with sample-atypical networks. These results indicate that alloparental networks may have a direct effect on perinatal depression, but no direct effect on physiological stress. This response may prepare mothers' for difficult rearing conditions by beginning the 'bargaining' early.

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#### **Change Between Femoral to Humeral Stable Isotopic Nitrogen and Carbon Values During Growth from a Sample of Subadults at Alytus, Lithuania**

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Analysis of stable isotopic nitrogen and carbon has been increasingly shown to demonstrate more complex physiological states of the human body during tissue formation than its initial use as an indicator of dietary protein types. Fuller and colleagues (2006) identified the effects of fetal development in maternal human hair where depleted  $\delta^{15}\text{N}$  values indicated growth through positive nitrogen balance. Yet, Waters-Rist and colleagues (2011) found no significant intra-individual variation in average  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  of the humerus between faster growing metaphyses of majority and opposing metaphyseal and midshaft samples for infants and children-juveniles. Continuing evaluations of intra-individual isotopic variation, this study compared the difference between bulk samples of midshaft femoral to humeral  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  ( $\Delta_{\text{F-H}}^{13}\text{C}\text{‰}$  and  $\Delta_{\text{F-H}}^{15}\text{N}\text{‰}$ ) for 68 individuals (32 weeks gestation- 16 years) from the Medieval cemetery of Alytus, Lithuania. Average  $\Delta_{\text{F-H}}^{13}\text{C}\text{‰}$  and  $\Delta_{\text{F-H}}^{15}\text{N}\text{‰}$  for the sample were negative toward greater overall enrichment of the humerus (-0.05



$\pm 0.25\%$ ;  $-0.01 \pm 0.45\%$ ) without significant intra-individual variation ( $\Delta_{F-H}^{13C\%} Q_{66} = 0.763$ ,  $p = <0.05$ ;  $\Delta_{F-H}^{15N\%} Q_{66} = 0.942$ ,  $p = <0.05$ ). However, cohort  $\Delta_{F-H}^{13C\%}$  and  $\Delta_{F-H}^{15N\%}$  averages demonstrated simultaneous enrichment in humeral nitrogen and carbon coinciding with commencement of weaning (2 years). Average cohort femoral enrichment coincided with growth spurts in the first year, childhood (5-7 years), and arguably adolescence (8.5-12 years). Small differences between femoral and humeral isotopic values reflect growth and are evident when developmental age cohorts are examined.

#### Mechanical properties of food items in the diet of the Sanje mangabey (*Cercocebus sanjei*)

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*Cercocebus mangabeys* exhibit dental and cranial modifications that enhance the ingestion of durophagous foods. It is often assumed to be an adaptation for the periodic consumption of mechanically protected fallback foods, such as seeds, eaten when the availability of preferred foods is low. This study tested the hypothesis that non-preferred foods (NPF), are harder to puncture and crush than preferred foods (PF, such as ripe fruits), and are only consumed during periods of low preferred foods availability.

Feeding and ecological data were collected on a study group of 30 adult Sanje mangabeys (*Cercocebus sanjei*) between December 2010 and November 2011 in the Udzungwa Mountains National Park, Tanzania. An agricultural fruit tester was used to measure puncture resistance and a valve spring tester was used to measure the crushing resistance of dietary items.

We found no significant difference in the puncture resistance between non-preferred and preferred foods ( $p = 0.807$ ), but crushing resistance was significantly greater in non-preferred foods (mean NPF =  $9.26\text{kg/cm}^2$ , mean PF =  $1.85\text{kg/cm}^2$ ; Wilcoxon  $Z = 2.11$ ,  $p = 0.0342$ ). Sanje mangabeys also consumed an extremely hard seed species, *Parinari excelsa*, which averaged  $711.9\text{kg/cm}^2$  (measured separately using a Zwick machine). These seeds represented only 5.5% of the annual diet but were consumed in all month, including those in periods of preferred foods scarcity, supporting a conclusion that durophagous feeding is a consistent factor in the diet of Sanje mangabeys.

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#### Integration Magnitudes and Patterns in Human and Great Ape Mandibles

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Magnitudes and patterns of integration have important effects on both the evolutionary trajectories of biological structures and the availability of morphospace for those same structures. While human mandibles are proportioned significantly different from those of the other great apes, a comparative investigation of integration in these structures has yet to be undertaken. Based on 16 linear and angular measurements from *Pan* (N=92), *Gorilla* (N=94), *Pongo* (N=87), and *Homo* (N=94), species variance-covariance matrices (VCVs) were produced. Simulated selection vectors were pushed through the VCVs to measure how the vectors were deflected, recording several integration statistics. Hominids do not appear to have significantly different magnitudes of integration (evolvability statistic: *Homo*=0.013, *Pan*=0.017, *Gorilla*=0.011, *Pongo*=0.015). Furthermore, preliminary analyses of the patterns of integration (evolutionary distance statistic: *Homo-Pan*: 0.008, *Homo-Gorilla*: 0.007, *Pan-Gorilla*: 0.013) indicate humans possess an intermediate pattern to that of chimps and gorillas, but more similar to either species than chimps and gorillas are to each other. These results suggest that the human mandible was not dramatically reorganized in order to achieve its unique position in morphospace. This has important implications for appreciating the selective agents that produced the much shortened, more arched, and chinned human jaw.

#### Experiential learning via research projects in freshmen biological anthropology courses

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Experiential learning is a hallmark of effective instruction but is believed to be unfeasible in large (>100 students) courses. Because many universities utilize large lecture-based classes for their introductory anthropology courses, undergraduates' initial exposure to anthropology often lacks opportunities to practice their learning. Since 2006, we have annually taught a large, introductory lecture course (Human Biological Diversity) that has, at its core, a group research project designed to engage students as scientists. We report herein on the difficulties, and more importantly, on the efficacy of this approach.

Most years, the students organize into groups that develop and implement a research project addressing some aspect of modern human biological variability. Each group is responsible for the proposal, data collection, analysis, oral

presentation, and formal write-up. Projects range from the unimaginative (Does stature predict arm length?) to the trendy (Does classical music improve speed/accuracy of doing arithmetic?) to the innovative (Do males sort colored objects by shape, rather than color, more than females do?). Research projects are "expensive" because they require substantial teaching assistant and instructor time, so one year we attempted to replicate the course learning outcomes without the project.

The non-project year had a 10% reduction in exam grades, largely from questions that required more integrative thinking than rote response. In project years, the innovativeness of the research project did not, however, predict course grade. As a first step in an ongoing evaluation, this anecdotal evidence lends credence to the role of experiential learning in developing integrative thinking.

#### Metric analysis of the Sima de los Huesos crania

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The large human cranial sample from the Middle Pleistocene site of Sima de los Huesos (SH) includes eleven adult crania, eight of which are fairly complete. This sample makes it possible to study the degree of variation in a number of craniometrical variables within a single biological population from the European Middle Pleistocene and compare the results with other Middle and Late Pleistocene hominin fossils and recent modern humans. Based on the main cranial dimensions, it is possible to distinguish two groups within the SH sample: crania 5, 10, 12, 15, 16 and 17 are smaller and probably females, while crania 2, 4, 8 and 13 show higher values in the main dimensions, especially in cranial breadths, and probably represents male individuals. The results show a degree of variation in the SH sample that encompasses the range of metric variation observed in African and European Middle Pleistocene fossils, both in vault and facial dimensions. Finally, the SH cranial vaults are absolutely and relatively tall compared with other archaic *Homo* taxa, but are comparable to fossil and modern *Homo sapiens* values. Interestingly, the frontal squama is receding in SH, like in other archaic *Homo* taxa. In our opinion, this relatively tall vault with a receding frontal represents an idiosyncratic trait of the SH population.

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## AAPA Abstracts

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### Leadership patterns within gelada reproductive units

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In group-living primates, decisions concerning 'where to go' and 'who to follow' are often mediated through social relationships with conspecifics. In most primate species, individuals live in closed social groups with stable membership. For primates living in modular societies, fission-fusion dynamics may cause individuals to make movement and foraging decisions based on unfamiliar individuals. In this study, I examine movement leadership patterns within gelada (*Theropithecus gelada*) reproductive units. I use two years of behavioral data (2013-2014, N=163 individuals, N=1282 focal hours) collected from a population of wild geladas living in the Simien Mountains National Park, Ethiopia. Preliminary results suggest that geladas fall into discrete movement 'initiator' and 'follower' categories, with few individuals being highly influential in determining group movement. Given the overlapping nature of gelada units, I suggest individual movement decisions may be more influenced by local rules and between-unit (i.e. spatial) relationships than by within-unit relationships.

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### Isotopic evidence for the origins of homicide victims from Qasr Hallabat

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Excavation of Qasr Hallabat, Jordan recovered the remains of six individuals from the bottom of an internal cistern. The qasr, once a luxurious Umayyad desert retreat, was abandoned after the fall of the caliphate in AD 749, and shortly thereafter was partially destroyed during an episode of seismic activity. The individuals, who died around 772-895 CAL AD, showed

perimortem and blunt force trauma caused presumably by outsiders unconcerned with contaminating a water source. Although it was evident that the individuals were victims of homicide, why the corpses would be dumped in a viable water source remains unclear.

Strontium and oxygen isotopes obtained from dental enamel were used to determine if the individuals were from region similar to Qasr Hallabat. These data can be used to illuminate the circumstances surrounding their violent deaths. Comparing these human ratios with archaeological faunal samples and published data on regional oxygen and strontium isotope variation, indicate that these individuals grew up in an area similar to Hallabat's. If they were indeed locals, then it appears that they 1) migrated from the region after childhood only to return and have a violent confrontation with another non-local group or 2) were locals attacked by a non-local population passing through the region. Both hypotheses indicate that the Hallabat region continued to be an economic crossroads even after the post-Umayyad decline.

### Exploratory data analysis in bioarchaeology using latent class analysis

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Exploratory data analysis (EDA) is a statistical approach to examining datasets for patterns, trends, and outliers (Gelman 2004). The function of EDA is an unbiased examination of the data unrelated to hypothesis testing. In archaeology, EDA, primarily in the form of cluster analysis, has a long history (e.g. Hodson et al. 1966); however, EDA is rarely utilized in bioarchaeology. This may be because a significant issue for cluster analysis, factor analysis, and most other EDA techniques is that they require complete datasets. Any cases with missing data must be removed from the dataset via listwise deletion, which often significantly reduces bioarchaeology sample sizes.

Similar to cluster analysis, Latent Class Analysis (LCA) attempts to classify cases from a sample into undefined groups (classes) using observed variables. However to explain the separation between groups, LCA uses conditional probabilities unlike cluster analysis, which uses scaled measures such as the Euclidean or Mahalanobis distance. Further, LCA can be run using *Mplus*, a statistics program created to perform mixture models and analyze datasets with missing data, thus reducing the impact of preservation issues on bioarchaeological data analysis. *Mplus* generates sample statistics using a full information maximum-likelihood-method (Muthen and Muthen 2010). This paper will demonstrate the utility of EDA using a poorly preserved bioarchaeological dataset from Medieval Asturias, Spain. In this example, LCA

found that a two-group solution was the most appropriate and further grouped a subset of all individuals with pathological conditions (n=13) separate from the rest of the population (n=219).

### A hallucal distal phalanx from Dmanisi, Georgia: Implications for early *Homo* foot biomechanics and evolution

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The Plio-Pleistocene (~1.77 Myr) fossil site of Dmanisi, Georgia has produced a rich assemblage of early *Homo* material, most recently referred to as *Homo erectus*. Much of the postcranial skeleton has been described and placed in a functional context of early *Homo* locomotion and biomechanics. Here we describe a distal hallucal phalanx (D2670) and compare it to a large sample of gorillas, chimpanzees, modern humans (both unshod and shod), Neandertals, and the only other described early *Homo* hallucal distal phalanx (OH10 - previously attributed to *Homo erectus*). Univariate and multivariate analyses of shape based on linear and angle measurements demonstrate that D2670 and OH10 are more similar to other species of *Homo* than to African apes, and D2670 and OH10 are more similar to each other than they are to modern humans. Like modern humans and Neandertals, both early *Homo* fossils have a relatively wide distal tuft with moderate lateral torsion, and a relatively wide mediolateral midshaft diameter. Unlike modern humans, they are relatively shorter and neither fossil phalanx has the characteristic human valgus orientation. Finally, midshaft cortical bone is thin in D2670 like modern humans, but it is thick in OH10 like great apes. The mixed morphology of D2670 (and OH10) is consistent with previous interpretations of other pedal material for early *Homo* from Dmanisi and elsewhere (in Africa). That is, early *Homo* may have had a functionally similar foot to modern humans, but its morphology still retained primitive features and may have differed within and out of Africa.

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### Rises in testosterone predict rises in dominance rank for male chacma baboons

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The challenge hypothesis posits that testosterone (T) and aggression are most closely related during times of intense reproductive competition. While results from seasonally breeding species have generally supported this hypothesis, those from non-seasonally breeding species have been equivocal.

Chacma baboons (*Papio ursinus*) are a group-living, non-seasonally breeding species. Competition for high rank equates to competition for mates because the highest-ranking males monopolize matings. Here we use noninvasive hormone samples (n=1,452) to examine how T relates to seasonal and social factors in adult male chacma baboons. Observational and hormonal data were collected from 2001-2005 on 26 wild males from the Moremi Game Reserve, Botswana.

First, we found that social challenges in chacma baboons were not seasonal, but occurred throughout the year. Second, when the hierarchy was stable (e.g., no rank changes within the top three dominance ranks), we found that the three highest ranking males had higher T levels than all lower-ranking males. Yet, when the hierarchy was unstable, only males that were climbing the hierarchy (within the top three ranks or climbed to one of these three ranks) exhibited elevated levels of T compared to males that were falling or stable in rank. Unless males were climbing to within these top three rank positions, T was unrelated to rising in rank. Finally, males that climbed to the alpha male position had increased T levels during the three months before the takeover and one month after. Our results suggest that elevated T levels among high-ranking males lead to higher dominance rank.

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### Identifying biological relatives in a deciduous dental sample: bioarchaeological implications

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Intracemetery biodistance analysis seeks to identify genetic relatives within archaeological contexts using phenotypic variation to estimate biological relatedness. Several different data types have been used in the past, with many favoring dentition. Permanent tooth morphology has been heavily utilized with varying degrees of success, while deciduous tooth morphology remains relatively under-developed. The exclusion of deciduous data from kinship analyses stems, in part, from a paucity of pedigree-based research focused on primary teeth. In this study, we evaluate the effectiveness of a deciduous morphological trait-set in accurately reproducing documented genealogical relationships. Because biological affines are more likely to share genes that are identical by descent, we expected relatives to share more similar deciduous morphology and lower biological distances than non-relatives. We quantified crown character expression in deciduous dental casts of 66 Burlington Growth Study participants housed at the University of Toronto, Faculty of Dentistry; data collection adhered to several published protocols. Employing 20 morphological traits, we generated 69 inter-sibling and 2040 non-relative Euclidean distances with distance ordination via multidimensional scaling. Results show average inter-sibling distance to fall significantly below the average of 69 resampled pseudo-distances generated from 999 replicates of mixed relative and non-relative pairs (d=0.252, p<0.001). Variability in family-specific averages is explored in relation to environmental and developmental instability and its potential effect on deciduous morphology.

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### The Identification of Traumatic Brain Injury (TBI) and Disability: Exploring Adult English Medieval Populations (1066AD - 1600AD)

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Research suggests that bioarchaeological studies have not addressed the vast and complex impact of TBI on people in the past. This is because evidence for specific disabilities following head trauma is limited and based on a small number of individuals. Consequently, research on TBI has focussed on the study of interpersonal conflict, survivorship, weaponry and surgical intervention. This research was a unique opportunity to use an historical perspective on TBI and disability to assess the care and health

outcomes of individuals with this type of injury, and how this might have differed in a variety of socio-cultural environments.

Skeletal collections from London, Norwich and York were utilised in the study. They were chosen because they were constantly evolving cities in AD1066-AD1600 and had large skeletal collections. There was also extensive archaeological and historical evidence to explore the social environment of the time.

Biological sex was estimated from sexually dimorphic features, age at death from macroscopic osteological methods and head injury data was assessed using criteria developed by a number of authors to determine the level of calvarial deformation and type of fracture. Finally, assessment for evidence of adaptation to physical change(s) was assessed using a variety of bone measurements, indices and radiographic evidence in an effort to determine limitations in activity, bilateral asymmetry and robusticity.

This cranial injury dataset begins to characterise the range of head injuries in people buried in non-battlefield cemeteries and indicates a significant number of individuals surviving substantive head injuries in both monastic and parish cemeteries.

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### Testing functional hypotheses about variation in African ape scapulae using 3D geometric morphometrics

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Differences in scapular morphology among African apes have long been observed, but the functional significance of this variation is unclear. We identified five features of scapular morphology hypothesized to vary with arboreality and tested resulting predictions.

Fifteen 3D landmarks were collected from scapulae of adult *Gorilla* (n=150) and *Pan* (n=210) and analyzed using geometric morphometrics. Differences between taxa were visualized, and predictions were tested based on observations that *Pan* is more arboreal than *Gorilla* and *G. gorilla gorilla* is more arboreal than *G. beringei beringei*, with *G. b. graueri* probably intermediate to the other *Gorilla* subspecies. Compared to *Gorilla*, *Pan* has a cranially angled glenoid fossa and acromion process, as predicted. Contrary to predictions, *Gorilla* has a wider supraspinous fossa, longer acromion process, more projecting coracoid process, and more laterally placed inferior angle.



These muscle attachment sites are probably larger in *Gorilla* to meet the demands of stabilizing the shoulder joint when this larger animal climbs. The subspecies of *Gorilla* varied as predicted, with the largest attachment sites in the more arboreal *G. g. gorilla* and the smallest in *G. b. beringei*.

This study suggests that a continuum of functionally-correlated scapular shape across African apes does not exist, probably because the great size difference between the two genera results in different biomechanical demands when climbing. It may be more productive for researchers to focus on the relationship between morphology and locomotor behavior within each genus.

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**Interdisciplinary anthropology approaches to health disparities research: sociocultural and genetic contributions to variation in blood pressure among African Americans in the Health Equity Alliance Tallahassee (HEAT) Heart Health study**

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African Americans experience greater risk of cardiovascular disease compared to other U.S. populations. The Health Equity Alliance of Tallahassee (HEAT) Heart Health study was developed to investigate this disparity among African Americans and work to improve heart health through community engagement. This community-based participatory research (CBPR) study design involved the collaboration of both medical and biological anthropologists with the goal of better addressing inequities in health outcomes.

Study participants were self-identified African Americans who consented to extensive sociocultural surveys that included questions on stress related to discrimination and unfair treatment and assessment of depression. Additionally, height, weight, and blood pressure were measured and saliva was collected for DNA extraction. Genotyping of each study subject was performed on a custom Affymetrix Axiom array that included ancestry informative markers for admixture mapping and SNPs in candidate genes previously reported to contribute to variation in blood pressure and risk of hypertension. Using admixture mapping on 159 participants with complete interview and genotype data we

identified regions on four chromosomes associated with variation in systolic blood pressure (SBP), four associated with diastolic blood pressure (DBP), and four regions associated with both SBP and DBP. Including sociocultural data from the surveys in the analysis resulted in modest improvements in these associations, particularly when related to stress (discrimination and unfair treatment) experienced directly by the study subject. Collaborative research by anthropologists that incorporates sociocultural and genetic factors has the potential to contribute to our understanding of health disparities.

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**A world-wide survey of humeral robusticity and midshaft shape**

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Although a widespread pattern of declining robusticity and decreasing antero-posterior (AP) reinforcement of diaphyses in the femur and tibia since the Early Upper Paleolithic (albeit with notable exceptions) is well-established, temporal or geographic trends in upper limb bones are less clear. To help address this problem, we present analyses of size-adjusted polar section moduli ( $Z_p$ ) and ratios of midshaft  $I_{max}/I_{min}$  for the humerus of Neandertals, Skhul-Qafzeh hominins, Gravettians, Magdalenians, Epigravettians, and 20 more recent samples, each subdivided by sex (total  $n = 985$ ). Right humeri were used whenever possible. Second moments of area were predicted from external dimensions or periosteal contours of the midshaft sections. Size-adjusted  $Z_p$  was calculated by dividing  $J$  by the half of the midshaft maximum diameter, then dividing by the product of humeral maximum length and body mass estimated from femoral head diameter. The results show no clear universal trend to decreasing or increasing humeral size-adjusted  $Z_p$ . Patterns in  $I_{max}/I_{min}$  defy a simple over-arching explanation and are not significantly correlated with size-adjusted  $Z_p$ . However, some interesting patterns emerged from the results: the females of each sample tend to have a lower mean value for size-adjusted  $Z_p$  than males, male foragers and herders from cold climates (e.g., Inuit, Sami, Tierra del Fuego, and Mesolithic French and Danes) tend to have particularly high values of size-adjusted  $Z_p$ ; Neandertal males follow this pattern but Gravettian males do not. Male Australian aborigines also have a remarkably high mean for size-adjusted  $Z_p$ .

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**Continuous or Pulse? Simulating Speciation and Extinction from Fauna at Plio-Pleistocene Hominin Sites**

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Species turnover was previously interpreted as pulses using fossil fauna at hominin sites over the past five million years; however simulated models of speciation and extinction do not support periodic turnover pulses. The Turnover-Pulse Hypothesis explains speciation and extinction events coinciding with appearances of novel hominin forms throughout the Plio-Pleistocene. Methodological and preservation biases have led to spurious conclusions about faunal turnover based solely on climatic shifts. Multiple factors beyond physical environment, including genetic predispositions, and autocatalysis contribute to evolutionary divergence. Using statistical modeling software (Matlab), continuous speciation, extinction, and differential preservation of fossil fauna were modeled over five million years. Simulated continuous turnover reveals similar patterns of fossilization to pulses. Patterns of faunal speciation and extinction coincide with continuous turnover. Speciation is difficult to interpret from fossil evidence but evolutionary pressures are continuous when considered across a geological timescale.

**Prehistoric use of *Ammotragus lervia* in Taforalta Cave**

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A useful means of assessing the emergence of modern human behavior comes from the reconstruction of subsistence strategies: here we look at remains of hunted animals in order to infer diet and behavioral flexibility of early modern people. We use *Ammotragus lervia* molar remains found in Sectors 8 (N=11; 7 had undamaged outer edges) and 10 (N=5) of Taforalta cave in Morocco. The teeth from Sector 8 represent the oldest Iberomaurusian in the Yellow series and continuing up into the base of the Grey; these deposits could be as old as 20,000 years ago. The teeth from Sector 10 are also of Iberomaurusian age and are associated with a cemetery.

*A. lervia* was a primary prey source for the entire range of populations using Taforalta--as evidenced by its presence throughout the

assemblages. We used standard dental cementum analysis to determine the season and age of death of this prey animal. In Sector 8, the majority (70%) of the hunted sheep were prime adults, suggesting a typical modern-human approach to hunting. All adults were killed at the transition between winter and spring. In Sector 8, there is a single late summer individual, but it is an old (opportunistic?) kill. In Sector 10, 60% of the specimens were adult, again all killed at the winter-spring transition. The only kill occurring in late summer was extremely young, and perhaps thus opportunistic. Thus, the results from Tavoralt suggest extremely organized and regulated hunting strategies, from at least 20,000 years ago.

**Is stress beneficial to longevity? Linear Enamel Hypoplasia (LEH) and age at death in the Medieval St. Gregory's Cemetery, Canterbury, UK**

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Recent findings have determined that certain pathological conditions, particularly those that manifest during childhood but still present during adulthood, could indicate survivorship. This study aims to determine if Linear Enamel Hypoplasia (LEH) frequencies are higher in people who lived into adulthood vs. those who died in childhood. The study controls for age, sex, and diet via caries, periodontal disease, and antemortem tooth loss (AMTL).

The author examined sixty-nine individuals between the ages of six and 30 from the Medieval St. Gregory's Cemetery, Canterbury, UK. Four age groups were created: subadults aged 6-12, 12-18, and young adult males and females aged 18-24, and 24-30. Four burials were male, 33 were female.

LEH values were: 6-12 year olds: 29% (n=17); 12-18 year olds: 20% (n=15); 18-24 year olds: 25% (n=16); 24-30 year olds: 16% (n=19). An inverse relationship between age group and LEH prevalence is present. Oral pathology data suggests the diet was cariogenic for all age groups.

LEH prevalence declined from childhood to adulthood contradicting the idea that those with LEH are more likely to make it to adulthood. Because LEH is usually idiopathic, it can reflect both non-lethal and lethal conditions and its value as survivorship indicators may be population-specific. Finally, the sample herein was mostly female and it is unclear if the results reflect a sex-specific phenomenon at Canterbury.

**Asymmetry in the cortical and trabecular bone of the human humerus during development**

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It has long been observed that the bones of the human upper limb display bilateral asymmetry, a phenomenon typically linked to handedness and lateralization. Few studies, however, have attempted to track asymmetry throughout ontogeny. This study assesses the ontogenetic development of cortical and trabecular bone asymmetry in the humerus. We predict that directional asymmetry in structural properties will emerge in concert with hand preference and increased activity levels during the juvenile period. Paired humeri from 57 individuals from the Norris Farms #36 archaeological skeletal collection ranging in age from neonate to adult were used in the current study. Cortical bone cross-sectional properties and three-dimensional trabecular bone structure were quantified from microCT data. The results indicate significant absolute asymmetry in all measured cortical and trabecular bone variables across all ages. Trabecular bone displays significantly higher absolute asymmetry than cortical bone. Contrary to expectations, however, this study found very little evidence for significant directional asymmetry in humeral length and cortical or trabecular bone variables. The exception is the significant directional asymmetry in cortical bone cross-sectional shape and polar moment of inertia in adults. The presence of significant absolute asymmetry in all age groups, and the lack of significant directional asymmetry in almost all variables at all ages, suggests that structural differences due to higher levels of habitual loading in the dominant arm are overlain on a template of potentially significant existing asymmetry.

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**Dominance relationships in male Nepal Gray langurs (*Semnopithecus schistaceus*)**

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Among nonhuman primate males living in multi-male groups, strong reproductive skew may be linked to despotism in dominance hierarchies. Although previous studies have investigated bias in paternity, it is often unknown if and how this relates to despotic relationships. Factors (e.g., resource holding potential) that affect a male's rank also remain largely unclear. This study examined male hierarchy characteristics and correlates of dominance rank in a wild population of Nepal Gray langurs (*Semnopithecus schistaceus*); a population with frequent male dispersal and strong reproductive skew. We predicted despotic hierarchies and high-ranking males to be of prime age and in best physical condition. Dyadic displacement interactions were collected over a 5-year period from two groups (mean 3.0 and 4.1 adult males). Using the program MatMan, displacements were analyzed for demographically stable periods (N=20, N=42). Hierarchies had high directional consistency (mean >0.88) and linearity (mean >0.79), with a relatively steep (mean >0.51) structure. While age did not influence male dominance rank in one group, young adults in the other group were highest ranking (GLMM, p<0.05). Males in the best physical condition did not attain the highest ranks. Hierarchy characteristics generally support a despotic system in line with the strong bias in paternity toward the alpha males. Overall, rank acquisition appears to be linked to resource holding potential, however results suggest other individual attributes also affect rank. Between-group differences in the link between age and rank suggest an influence of group composition on male rank relationships.

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**Investigation of Nonspecific Stress Indicators in Middle and Older Female Adults from Rural and Urban Post-Medieval London**

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Post-medieval (1550-1850) London was characteristically urban. Dramatic increases in population size, density, and urbanization occurred alongside industrialization. Urban residents would have encountered air pollution, overcrowding, and communicable disease. In contrast, rural residents living in the outskirts of the city were less likely to have been exposed to the same environmental conditions urban residents experienced. Due to overcrowding, pollution, and increased disease rates found in urban environments, it is hypothesized that higher physiological stress occurred in urban London compared to rural areas. This project examines trends in urban and rural skeletal health measured by analysis of non-specific

indicators of stress. The study sample is composed of middle (35-50 years) and older (50+ years) female adult individuals from an urban cemetery, St. Bride's crypt (n=33), and a rural cemetery, Chelsea Old Church (n=32). These results suggest that non-specific indicators of stress were generally similar in the two locations, with only a significant difference in the prevalence of periostitis. Also of importance, this study provides a window into the skeletal health of females who persisted into older age during the post-medieval period in London, and contributes to the understanding of general patterns of osteological evidence of health in older adult females.

**Nuclear genome sequences from the extinct subfossil lemurs *Palaeopropithecus ingens* and *Megaladapis edwardsi***

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Benefitting from recent advances in DNA sequencing technology, paleogenomic analyses of Neandertal and Denisovan nuclear genome sequences (the ~3 billion bp nuclear genome contains ~25,000 genes and is much more relevant for phenotypic inference than the ~17kb mitochondrial genome; yet mtDNA is much more readily sequenced in ancient DNA studies, because there are hundreds to thousands of mitochondria per cell) have started to provide valuable phenotypic insights about these extinct hominin populations. Our group has been applying similar paleogenomic approaches to extinct 'subfossil' lemurs. To date, we have screened >150 subfossil lemur samples for general DNA quality. While levels of DNA preservation have proven sufficient for population-level mitochondrial genome studies (up to n=21 individuals per species; Kistler et al., in press), the quality of ancient DNA obtained from the subfossil lemur skeletal material (from relatively hot and/or humid Madagascar) is generally much lower than that from the better-preserved Neandertal and Denisovan samples. However, we did identify samples from two

species, *Palaeopropithecus ingens* and *Megaladapis edwardsi*, that were sufficiently preserved for nuclear genome analysis. Here we present the results from our initial analyses of low-coverage (~2x) nuclear genome sequence data from these two species, focusing on genes involved in vision, taste, and olfaction sensory perception. These analyses complement previous and ongoing investigations based on skeletal morphology, dental microwear, dental topography, dental internal structure, and stable isotope (especially  $\delta^{13}\text{C}$  but also  $\delta^{15}\text{N}$ ) values to construct a more complete understanding of the behavioral ecology and environments of these extinct lemurs.

**Body mass estimation in platyrrhines: Methodological considerations and fossil applications**

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Studies of catarrhine primates have demonstrated the utility of long bone articular dimensions in estimating body mass. Here, data from the long bone articular regions of nine platyrrhine species (total n=64), representing a broad size and locomotor range, were used to estimate body mass in six species of fossil primates (n=23). Diameter of the femoral and humeral heads, as well as the mediolateral breadth of the distal femur are precise predictors (%SEE = 15, 13, and 17, respectively). Bicondylar breadth of the distal humerus is less precise (%SEE = 25). These results are comparable to those obtained with 3D landmark data. Mean body mass estimates for fossil platyrrhines generally fell close to ones previously published: *Protopithecus*, 30kg; *Caipora*, 19kg; *Xenothrix*, 3.5kg; *Paralouatta*, 7.6kg; *Homunculus*, 3kg; *Cebupithecia*, 1.7kg. However, those for *Xenothrix* and *Paralouatta* fall below published estimates. The estimate for *Protopithecus* is high relative to those obtained from 3D landmark data. Estimates for *Protopithecus* and *Caipora* should be viewed with caution because their skeletons are considerably larger than those of the extant platyrrhines. Most of the variation among body size estimates is among predictors, rather than among individuals. This suggests that different joints scale differently in platyrrhines, perhaps due to differences in locomotor style. Thus, it is important to consider differences in locomotor style when estimating body mass from long bones. This result also highlights the importance of relatively complete fossil

skeletons, without which it is difficult to assess relative joint size.

**Foreigners in Fröjel?: A Study of Mobility on a Viking Age Port of Trade in Gotland, Sweden**

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Ridanäs was an important port of trade on the island of Gotland, Sweden, in use during the 7-11<sup>th</sup> centuries, AD. Excavations have revealed the presence of two Viking Age (800-1070 AD) graveyards containing over 80 individuals. This study examined the remains of 60 of these individuals buried in the Viking graveyards. Strontium isotope analysis was used to determine whether they were local or non-local to the trading port. In addition, 13 archaeological faunal samples were analyzed in order to define the local bioavailable strontium isotope baseline range. It was hypothesized that the Ridanäs population would consist of locals and non-locals who came to Gotland to take advantage of its successful trade economy. Results, however, showed that only 4 of the 60 individuals were non-local to Gotland, indicating that non-locals did not seek long-term residency at this port of trade.

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**What can the skeleton tell us about flanging? Hard-tissue markers of cheek flanges in *Mandrillus***

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Variation in sexual selection mechanisms according to differences in mating systems and competitive regimes leads to variation in reproductive traits. A major challenge in paleoanthropology is reconstructing the behavioral strategies of extinct hominins represented only by fossils. Canine size and estimates of body size are used to infer sexual dimorphism as a proxy of socio-sexual behavior; however, these are somewhat limited and other bony correlates of soft tissue sexual traits may be more informative. This study assesses the cheek flanges that characterize adult male drills (*Mandrillus leucophaeus*) but not closely related mandrills (*Mandrillus sphinx*) in an attempt to



identify potential osteological markers that characterize this secondary sexual characteristic. To quantify bony correlates of cheek flanges, a suite of cranial measurements was taken in addition to the non-metric quantification of zygomaticofacial foramina, which house the vessels that innervate and vascularize the fleshy cheek pads. The results show that adult male drills are characterized by wider zygomatics (and wider faces overall) and a higher number of zygomaticofacial foramina than mandrills. This suggests that this soft tissue trait can be identified in craniofacial skeletal morphology in the genus *Mandrillus*, which has implications for the identification of fleshy cheek flanges in fossil primates.

#### **Macaques and the Ritual Production of Sacredness among Balinese Transmigrants in South Sulawesi, Indonesia**

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Long-tailed macaques (*Macaca fascicularis*) at temple sites in Bali are often protected by local residents. An underlying cause of this protection is that the macaques may be considered sacred due to the presence of monkeys in Hindu texts, or through their frequent occurrence in sacred temple spaces. Macaque spatial context is an important component of the human-macaque interface in Bali because the revered long-tailed macaques may be shot at or chased away when found in or around agricultural plots. This research was conducted with Balinese transmigrants living in South Sulawesi, outside of Bali, to better understand the influence of space (sacred and non-sacred; ancestral and migratory), and other issues, on Balinese Hindu perceptions of macaque sacredness. Semi-structured interviews were conducted with 100 individuals from three transmigrant communities regarding their relationship with local booted macaques (*Macaca ochreata*). We found that the majority of transmigrants did not consider booted macaques sacred. Reasons given for this lack of sacredness included the absence of macaques in and around temple sites in these transmigrant communities, as well as frequent crop-raiding behavior. These results also have implications for the perception of macaque sacredness in Bali. The presence of long-tailed macaques at temple sites in Bali alone does not result in their sacredness, but rather it's their nondisruptive behavior during rituals that contributes to their perceived sacredness. This re-conceptualization of macaque sacredness importantly situates macaques and humans as sharing in the production of macaque sacredness.

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#### **Documenting the first steps out of Africa: New findings from Arabia**

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The Arabian peninsula is in a central geographic location between Africa and the rest of Eurasia. Despite its central location, relatively little palaeoanthropological research has been conducted until recently. Here we examine and report on new interdisciplinary archaeological findings from the Arabian peninsula. The aim is to address the relationship between climate change and hominin occupation history over the long term. Satellite imagery, climate simulation studies and environmental research indicate alternate wetting and drying of Arabia over the long term. Field studies have identified large numbers of Acheulean sites, localities distributed over landscapes measuring more than 100 km. Middle Palaeolithic sites, dated to between MIS 9 to 3, are associated with riverine and lacustrine settings. Quantitative analysis of Lower and Middle Palaeolithic industries demonstrates significant regional diversity, indicative of temporal change. Site density data and temporal gaps in the record suggest short term occupation intervals and regional abandonments, likely owing to the effects of climate change. Implications for the effects of climate change on the survival and movement of archaic and modern humans are discussed.

#### **Funded by the European Research Council**

#### **Effects of early life experience on cortisol/salivary alpha-amylase symmetry in free-ranging juvenile rhesus monkeys**

LAUREN A. PETRULLO<sup>1</sup>, TARA M. MANDALAYWALA<sup>2</sup>, DARIO MAESTRIPIERI<sup>3</sup> and JAMES P. HIGHAM<sup>1</sup>. <sup>1</sup>Department of Anthropology, New York University, <sup>2</sup>Department of Psychology, New York University, <sup>3</sup>Department of Comparative Human Development, University of Chicago.

Maternal neglect and abuse occur in both humans and rhesus monkeys (*Macaca mulatta*). These phenomena represent forms of early life stress and have profound effects on an individual's development. In humans, repeated exposure to early life stress affects the functional symmetry of the two systems of the physiological stress response: the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis. The SNS and HPA axis are expected to function symmetrically, but maltreated human children have been shown to exhibit asymmetry in biological markers reflecting activity of these two systems. Here, we test for a similar effect in juvenile rhesus monkeys. We collected 158 saliva samples over the course of two months from a cohort of 24 juveniles, which have been monitored since birth, from two naturally formed social groups on

Cayo Santiago, Puerto Rico. Behavioral data were also recorded *ad libitum* during the saliva collection period. The saliva samples were assayed for cortisol (as an HPA biomarker) and alpha-amylase (as an SNS biomarker); these data were then combined with extensive behavioral data collected during this cohort's infancy. Our data help to elucidate the relationship between maternal neglect and abuse and physiological development, which is likely to be linked to long-term inter-individual differences in behavior and life-history.

#### **Comparing avian and terrestrial scavenging evidence and addressing why the Crested Caracara (*Caracara cheriway*) steals bones**

LAUREN R. PHARR, MICHAEL LEITNER and MARY H. MANHEIN. Department of Geography and Anthropology, Louisiana State University.

Avian and terrestrial scavengers play a critical role in both forensic anthropology and archaeological investigations by (1) accelerating decomposition through rapid tissue removal, (2) causing pseudo perimortem trauma on the bones, and (3) dispersing the remains from the original deposition site. Previous studies have noted that vultures accelerate decay and much attention has been given to the impacts terrestrial scavengers have on physical anthropology investigations. However, few studies have assessed differentiating and quantifying avian and terrestrial scavenging evidence occurring on the same set of skeletal remains. To address the challenges in distinguishing avian from terrestrial skeletal trauma, we placed 43 deceased pigs in the fresh stage of decay across 6,000 km<sup>2</sup> in south central Texas during 2011 and 2012. The pigs were not protected from either avian or terrestrial scavengers and each scavenging sequence was monitored via remote infrared photography. Results revealed that turkey vultures (*Cathartes aura*) and black vultures (*Coragyps atratus*) were the most frequent scavenger (N=38) at the 43 pig trials and the gray fox (N=8) (*Urocyon cinereoargenteus*) was the most frequent terrestrial scavenger. However, the crested caracara (*Caracara cheriway*) had the greatest impact on the presence or absence of skeletal remains because this bird did not consume the remains but instead would grab a bone and then fly away. Knowledge of the caracara's tendency to steal bones from a site both during and after scavenging episodes of vultures and other terrestrial scavengers can offer new insight as to why expected skeletal data is absent from deposition sites.

#### **Micro high-resolution x-ray computed tomography of fossil Plesiadapiform (stem-primate) teeth to remove inter and intra specific measurement errors**

CLAYTON D. PILBRO. Department of Anthropology, Western Michigan University.

Computed tomography (CT) is a three-dimension imaging system for producing virtual models of an object. Use of CT scans is a relatively new tool for paleoanthropology and paleoprimatology. Micro-CT imaging techniques are increasingly utilized by paleoanthropology for morphology studies and to facilitate data sharing. However, use of CT scanners as a universally accurate measurement tool has been overlooked. Micro-CT technology has greatly improved, allowing increasingly smaller objects to be scanned rapidly at high resolution. Scanning techniques allow non-destructive, comparative studies of fossil teeth/bone and comparison to extant, analogous species material. On a much more basic level, CT imaging provides nanometer resolution measurements to accurately render three-dimensional models. This resolution allows uncompromised measurement data of fragile, rare specimens and type materials in university and museum collections. Exact measurements of specimens and morphologic features can therefore be virtually gathered by anyone by use of virtual loans, websites, and digital collections. These measurements remove both inter and intra observer error during measurement of microfossils. Individual teeth and jaw fragments measuring less than 1.0 mm from two different *Phenacolemur* (*Paromyia*, Plesiadapiform, stem-primates) species were measured using digital calipers, microscope reticles, and Micro-CT scans to demonstrate the differences, and the importance, of sub-millimeter accuracy in microfossil statistical analysis. While traditional tools and means of measurement can result in as much as 0.3mm +/- of error, Skyscan Micro-CT slices can reach 6µm +/- . Resulting measurements from scans had no inter or intra observer errors.

#### Population systematics of *Pongo* from discrete dental traits

VARSHA PILBROW. Anatomy and Neuroscience, University of Melbourne.

Orangutans (Genus *Pongo*, Family Hominidae) are Asian apes closely related to humans. Two species are recognized from Borneo and Sumatra, with the Bornean orangutans further subdivided into three subspecies. This classification is based on molecular and craniometric data; however, a dental classification is not as well established. Given the relevance of dental morphology and orangutans for human evolutionary studies the purpose of this research is to characterize the discretely occurring dental traits differentiating currently recognized species and subspecies of extant *Pongo*.

Dental sample of 102 orangutans with known provenience were divided into subspecies (*P. p. morio* = 4; *P. p. pygmaeus* = 63; *P. p. wurmbii* = 10) and species (*P. abelii* = 25). Dental traits were documented on incisors, canines, premolars and molars. Frequency counts with chi-square

statistics ( $p < 0.05$ ) and mean measures of distance were used to establish differences between taxa.

Compared to *P. abelii*, *P. pygmaeus* has higher frequencies of marginal ridges on incisors, deeper grooves on canines, greater likelihood of metaconids on  $P_3$ , protoconule on  $M^3$  and protostylid on  $M_3$ ; while *P. abelii* has higher frequencies of continuous longitudinal grooves and crests on premolars and molars. The sample sizes for subspecies of *P. pygmaeus* are limited in this study. Nonetheless, they are differentiated by the pattern of lingual cingulum on incisors, pattern of occlusal crenulations on all teeth and formation of the anterior transverse crest on the upper molars. On the whole, interspecies differences between *Pongo* are not as marked as those between *Pan* and *Gorilla*.

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#### The plesiomorphic condition of the great ape femur: biomechanical evidence from the IPS41724 femur (middle Miocene, NE Iberian Peninsula)

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Miocene apes display a mosaic of primitive and derived hominoid features conferring them a body plan with no modern locomotor analogs. Thus, the external morphology of the proximal femur in available fossil apes most closely approaches the extant ape condition. However, femoral mechanical properties and internal structure in extinct apes are less well known, even though they are essential to understand the evolution of loading regimes at the hominid hip joint. We analyzed the biomechanical properties of the proximal femur IPS41724 from ACM/C3-Az (11.9 Ma, NE Iberian Peninsula), the oldest femur attributed to a fossil great ape (cf. *Dryopithecus fontani*). Externally, this femur combines primitive (e.g., laterally protruding greater trochanter and presence of third trochanter) and derived features (e.g., large and round head and high neck-shaft angle). Unlike in extant apes, the internal structure of the neck in IPS41724 exhibits a generalized monkey-like asymmetric distribution of the cortical bone, being superiorly thinner. Diaphyseal cross-

sections display an ellipsoidal shape (anteroposteriorly flattened), with a great amount of cortical bone (mainly at the subtrochanteric level) and similarities with chimpanzees regarding bending strength. Thus, whereas the external morphology of IPS41724 is mainly modern ape-like, the stereotyped loadings at the neck and the shaft structural properties are similar to extant monkeys and knuckle-walkers, respectively. Thereby, we conclude that IPS41724 would have been less specialized for enhanced hip abduction than later Miocene taxa, with significant implications for inferring the plesiomorphic condition from which the locomotor repertoires of extant apes and bipedal hominins evolved.

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#### Forensic ancestry assessment using cranial nonmetric traits traditionally applied to biological distance studies

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The purpose of this study was to investigate the utility of cranial nonmetric trait data traditionally used in biological distance studies for forensic ancestry assessment in modern populations. The literature attests to the usefulness of cranial nonmetric trait data for revealing patterns of biological relatedness within and among regional populations. A natural extension is the development of classification models for forensic application based on this class of data. Recent work has demonstrated successful classification of unknowns based on dental nonmetric trait data. This project commenced with the hypothesis that cranial nonmetric trait data would be similarly effective for classifying an unknown individual by ancestral group. Data were collected from 200 crania of African and European ancestry from the Terry collection. Multiple datasets were evaluated where in the case of bilateral traits either a side was randomly selected or maximum trait expression was recorded. Several classification methods were compared including methods such as Support Vector Machines that are commonly used in biomedical research, but are relatively novel to anthropology. The resulting models were moderately successful with correct classification rates ranging from slightly better than chance to approximately 80% for machine learning methods.

This research takes a step towards utilizing cranial nonmetric trait data outside the realm of bioarchaeology. The potential to develop more complex models of greater value to forensic

anthropologists is also discussed given the results of this study, and in light of the recent publication of Ossenberg's cranial nonmetric trait database that samples world-wide populations.

#### **Evolve: Gameplay in Introductory Biological Anthropology Courses**

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Today's students learn differently compared to those of a generation ago. This change in learning style has left instructors teaching introductory biological anthropology courses searching for innovative pedagogical techniques such as games. Gamification, or the use of game mechanics, techniques, and theory in non-game contexts, has been shown to be particularly helpful in increasing student engagement and learning outcomes. In this poster we introduce *Evolve*, a novel game-based learning tool for use in introductory biological anthropology classrooms. *Evolve's* innovative game structure goes beyond traditional pedagogical techniques (i.e., lecturing, reading, writing, etc.) and involves multiple interactions with images, text, diagrams, and symbols. Through low-risk competition, students are actively learning course material and are engaged as participants, not as passive players. Similar to other research examining the efficacy of gameplay in the classroom, preliminary in-class observations and student feedback have shown that *Evolve* leads to better student learning and has great potential as a strategy to enhance student outcomes in introductory biological anthropology courses.

#### **New specimens of *Australopithecus anamensis* from Kanapoi, Kenya**

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*Australopithecus anamensis* represents the origins of the *Australopithecus-Homo* clade, but remains poorly represented in the fossil record. For this reason, it is significant that renewed fieldwork at Kanapoi, Kenya, from 2012-2014 has yielded new *A. anamensis* fossils. These include a partial mandible with complete dentition, maxillary fragment preserving left C-P4 and a partial lower face, the rest of the previously published partial dentition KNM-KP 47953, numerous isolated teeth, and fragmentary postcrania.

The new specimens confirm the morphologies previously identified as diagnostic of early *A. anamensis*. The maxilla demonstrates the large, vertically implanted canine root and rounded lateral nasal margin seen in the only other maxillary specimen from Kanapoi. The two new anterior mandibular dentitions confirm the relatively wide lower lateral incisors that likely contribute to the differences in overall tooththrow morphology between *A. anamensis* and *A. afarensis*. The mandibular symphysis is strongly sloped, canine tooth roots large, postcanine teeth with strong buccal flare, and the typical *A. anamensis* canine-P3 complex is present. Although the distinctive sloping protoconid is present, the mandibular P4 talonid is more expanded than in any other Kanapoi specimen, suggesting more variable talonid size than previously appreciated.

The new fossils confirm the distinctive morphology of *A. anamensis* compared with *A. afarensis*, while expanding known variation in premolar morphology. The new fossils are consistent with the hypothesis of morphological change throughout this lineage, perhaps related to changes in dietary behavior.

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#### **3D Vertebral morphology, locomotion, and human spinal health**

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Recently, we investigated the relationship between locomotion, spinal pathology, and the 2D shape of the final thoracic and first lumbar vertebrae in humans, chimpanzees, and orang-utans. The spinal pathology we focused on was Schmorl's nodes, which are depressions on the vertebral body resulting from vertical herniation of the intervertebral disc. We found that pathological human vertebrae share more similarities in shape to chimpanzee vertebrae than healthy humans do. This suggests that the occurrence of inter-vertebral disc herniation may be influenced by a particular vertebral shape that is more susceptible to the stress placed on the spine during bipedalism.

To further explore this possibility, we initiated the investigation of the 3D shape of human, chimpanzee, and orang-utan first lumbar vertebrae using geometric morphometrics. The

analysis of 3D landmarks enables a more detailed exploration of vertebral shape than is possible with 2D analysis. Our preliminary findings are consistent with the results of our previous, 2D study. They indicate that the 3D shape of L1 human vertebrae with Schmorl's nodes again share similarities in shape with chimpanzee vertebrae. The results of a Canonical variates analysis found that the Mahalanobis distances were significant between all inter-taxon comparisons, except between healthy and pathological humans, and pathological humans and chimpanzees. These results should contribute to the understanding of why humans are so often afflicted by back problems and may also have diagnostic value for clinical medicine.

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#### **The Smithsonian's Human Origins Program: Broadening and deepening public engagement with human evolution through social media**

BRIANA POBINER. Department of Anthropology, Smithsonian Institution.

According to the Gallup Poll, while the proportion of American adults who accept the evidence for human evolution without any theistic involvement has risen slightly over the last 20+ years, it still remains below 20%. In 2005, the US scored next to last in a study of 34 countries on acceptance of human evolution, all while new discoveries about human fossils and genetics continue to generate intense public interest and grace the covers of major science research and journalism magazines. Upon opening the Smithsonian's Hall of Human Origins in 2010, we created Facebook and Twitter accounts with the goal of engaging the public about human evolution through social media. Two of our social media strategies are to broaden our audiences by connecting human evolution content to everyday experiences and popular events, and to deepen our interactions with these audiences by fostering genuine dialogue. We can measure the former by the consistent increase in Facebook fans (>8,600) and Twitter followers (>12,900), and the latter by metrics such as conversation, amplification, and applause rates. I present a case study of a recent Twitter tour of the Hall of Human Origins in July 2014 to exemplify our ability to communicate science content, highlight exhibition objects, personalize scientists, connect to local current events, and interact with our followers using genuine dialogue. This first experiment with a new social media engagement strategy for the Smithsonian produced an estimated reach of over 1.3 million Twitter accounts with over 12 million impressions.



### **Evolvability and Autonomy of Limb Proportions in *Homo* and other Hominoids**

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Relative limb proportions can be used to discriminate among primates that use different locomotor behaviors, with humans having relatively longer lower extremities and suspensory and knuckle walking apes having relatively long forelimbs. Understanding the developmental and evolutionary origins of this differentiation is key to explaining human and hominoid locomotor evolution. This research tests the hypothesis that greater limb differentiation is associated with higher evolutionary autonomy for limb segment lengths. Humeral, ulnar, femoral and tibial lengths were measured for large samples of *Homo*, *Pan*, *Gorilla*, *Pongo*, *Hylobates*, *Macaca*, *Cercopithecus*, *Ateles*, and *Alouatta*. Species-specific phenotypic correlations, measures of evolvability and autonomy were obtained for each bone following mean-standardization for sex and population differences. In general the elements of animals showing greater limb differentiation tended to have greater autonomy, but this was not always the case for all species (e.g. *Pongo*), and some quadrupeds also had high limb element autonomy (e.g. *Alouatta*). Typically greater autonomy was found for forelimb elements than hind limb elements, and distal elements were usually more autonomous than proximal elements. These results suggest that most hominoids are characterized by increased evolutionary autonomy in their limb lengths, but levels of autonomy do not explain limb length differences (or similarity) in all primate species. Instead, some clade-specific differences in the degree of evolutionary constraint may exist.

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### **Pott's in Bones Rather than Bones in Pots: Identification of Pott's Disease (Tuberculosis) Through a Cooperative Approach**

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This presentation discusses the identification of a skeletal pathology through the cooperation of the medical examiner, forensic investigator and forensic anthropologist. We highlight the etiology of tuberculosis, specifically Pott's disease, and its differential diagnosis. We draw

attention to feedback loop of diagnostic criteria shared between the medical examiner, skeletal analysts and death investigators.

Tuberculosis, a chronic infectious disease, arises from *Mycobacterium*. Direct transmission from human-to-human is caused by *Mycobacterium tuberculosis* that are most commonly routed through the respiratory tract with the subsequent lung or lymph node infection. When the tubercle bacilli manifests on bone, it predilects the hemopoietic vertebral column, and becomes vertebral tuberculosis or Pott's disease.

In 2013, we evaluated the decomposed unidentified remains of a male discovered floating in a drainage ditch in Naples. The medical examiner's autopsy revealed no evidence of tuberculosis. Rather, she noted right lung adhesions to the chest wall, which she considered age-related or pathological. Our team noted skeletal lesions consistent with 11 chronic bacterial infections, including leprosy, treponematosi, and brucellosis. Because we rarely have access to medical records until after a presumptive identification, we stress the process of differential diagnosis with medical examiner personnel and vice versa.

Due to the evidence provided by the District 20 Office of the Medical Examiner and the osteological analysis highlighting Pott's disease, we confirmed the pathology.

### **Birth at the extremes: exploring fetal-maternal obstetric and metabolic relationships in small and large primates**

MARCIA S. PONCE DE LEÓN and CHRISTOPH PE. ZOLLIKOFER. Anthropological Institute and Museum, University of Zurich.

Schultz' and Leutenegger's pioneering studies on maternal-neonate relationships in primates have provided important insights into the various causes and constraints governing the evolution of primate birth. Meanwhile, the focus of attention has shifted from primates in general to modern human and fossil hominin birth mechanisms. Also, a recent study has triggered a major change of perspective, suggesting that the size of the human newborn is limited by metabolic rather than anatomical obstetric constraints. To explore the relationship between anatomical and metabolic constraints, comparative data from a wider range of taxa are required. Here we use biomedical imaging methods to acquire volumetric data from cadaveric anthropoid primate specimens of all age groups (fetal to adult), and across a wide range of species (*Cebuella* to *Gorilla*). We use these digital 3D data to simulate the birth process on the computer screen and assess fetopelvic relationships. Obstetric relationships are then compared with metabolic relationships between mothers and neonates. Results indicate that,

toward the lower size range of primates, birth tends to be spatially constrained. Metabolic constraints, however, tend to be ubiquitous and independent of fetal-to-maternal body size proportions.

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### **Humans, the high-energy ape: hominoid energetics and life history evolution**

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Humans have the largest brains, longest day ranges, and fastest reproduction among the living hominoids. Here we compare total energy expenditure, TEE, reported for a broad range of human populations and to new measurements of TEE and activity in zoo and sanctuary populations of chimpanzees, bonobos, gorillas, and orangutans to test the hypothesis that humans' unique metabolic demands are met through an evolved increase in energy throughput. TEE was measured using the doubly-labeled water method, and physical activity was measured using focal follows. Multivariate analyses of TEE controlling for fat free mass and activity level indicate substantial metabolic diversity among hominoids, with humans having greater TEE than other apes. Physical activity had a limited, non-linear effect on TEE in both humans and apes, with diminishing effects at higher levels of activity. Instead, non-exercise physiological activity appears to play an important and underappreciated role in determining daily energy requirements, both within and between species. These results challenge longstanding reconstructions of human life history and brain evolution and suggest a new framework for investigating evolved energy requirements and metabolic health in humans and other apes.

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### **Spatial and Temporal Dynamics among Groups of Wild Bolivian Saddleback Tamarins (*Saguinus weddelli*)**

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Previous studies of wild tamarin groups have demonstrated that groups are generally polyandrous, competition for breeding positions is high among both sexes, and allocare is common. To assess how these factors influence tamarin group spatial and temporal dynamics, we monitored 4 groups of Weddell's saddleback tamarins in northwestern Bolivia from June 2013 to September 2014. Groups were trapped at the start and end of the study to document changes in membership. We also recorded GPS coordinates of the groups' locations at 30 min intervals throughout observation days to describe home range usage. All groups were mixed-sex, and contained a mean of 5.9 individuals (range 2-11), including 1.4 adult females (range 1-3) and 2.2 adult males (range 1-4). Twin infants were born to a single female in each group during the period of October – January. Of the 15 animals trapped in 2013, 8 were recaptured in the same group in 2014, 3 were found in a different study group, and the remaining 4 were not recaptured. Home ranges were on average 33.7 ha with a 9.4 ha core area (95 and 50% KDE, respectively). On average, 22.2 ha (67%) of each group's home range overlapped with their neighbors' ranges and intergroup encounters were common, occurring on up to 20% of observation days/month. These observations suggest that extensive home range overlap and frequent encounters may facilitate group transfers, and that high turnover in group membership may result from intense competition for breeding positions among males and females.

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#### **Functional Implications of Maximum Skeletal Gape in Non-Human Primates**

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Maximum jaw gape has important functional implications for behavior and feeding habits in primates. It has been suggested that gape is correlated to canine height and ingested food size. Extending these correlations to the fossil record would provide dietary insights about extinct primates; however, this can be problematic for several reasons, including uncertainty about size and location of musculature and logistics of reliably estimating maximum gape using only skeletal elements. In this study Maximum Bony Gape (MBG) was estimated using reliable landmarks and

repeatable methods. The skull was positioned at centric relation and then the mandible was rotated and translated to the point immediately prior to loss of condyle-glenoid contact. Then it was held in a steady position using a novel instrument, an adjustable wooden frame. This allowed for photographs and linear measurements to be obtained for many museum specimens in a short time. The sample included 192 individuals, representing 39 species of primates.

When scaled for body size, MBG did not correlate with scaled condyle height or with maximum anesthetized gape (Hylander, 2013). This lack of correlation suggests that soft tissue (including muscle) anatomy plays a role, along with bony anatomy, in determining gape in life. Scaled MBG does correlate with scaled ingested food size (Perry and Hartstone-Rose, 2010). This suggests that bony constraints on gape play a role in determining ingestive behavior. This study provides evidence for caution when attempting to estimate maximum gape from fossils in the absence of independent evidence of oral behaviors and food properties.

#### **A possible case of cleft palate in early Florida as identified through 3D imaging: The intersection of modern technology and bioarchaeological analysis to record and analyze behavior and medical conditions of an Archaic--Glades II population**

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Bioarchaeological analyses were conducted on five features from the Miami One site (8DA11) in Southern Florida. Remains were dated to the Archaic to Glades II period (1000 BC-1000 AD). The MNI was determined to be 204. We hypothesized that the remains would express a high prevalence of skeletal markers of malnutrition and evidence of early life mortality.

Evidence of high early life mortality and severe nutritional stressors were absent. Reconstruction and 3D imaging of a mostly complete left and right maxilla allowed for greater insight into the population's health issues. The fragmented bones demonstrated that the individual had a well healed defect along the intermaxillary suture posterior to the incisive fossa and continuing towards the palatines. The defect is consistent with a case of complete cleft palate without apparent associated changes to the bony portions of the lingual or exterior nasal regions. Aging of the individual indicates survival well into adulthood.

Cleft palate is a failure of the maxillae to fuse correctly during fetal development. Afflicted individuals face severe health issues, many

producing a failure to thrive in infants. The condition is poorly recorded in the bioarchaeological record (Phillips and Sivilich 2006). Differential diagnoses include: masses and trauma. Extensive healing and a continuation of aging indicate social conditions that provided care for the individual.

We reject our hypothesis that life was difficult and short. Digitalization of remains, especially those necessitating immediate reburial, ensures opportunities to assess the lives of ancient populations and should be an essential component of bioarchaeological investigations.

#### **Plantar pressure distribution patterns during carrying: Implications for inferring behavior from fossil footprints**

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Humans are the only mammals known to move resources across substantial distances. This behavior, which combines habitual bipedalism with use of the arms or head for carrying, has been linked with the emergence of two aspects of modern social dynamics: alloparenting and non-infant provisioning. Unfortunately, most paleontological and archaeological evidence of carrying is indirect, and its role in hominin evolution is difficult to test. However, fossil footprints directly record aspects of locomotion, such as foot pressure distribution, representing an opportunity to identify evidence of carrying behavior in the fossil record. This study tests the hypothesis that carrying objects produces unique plantar pressure patterns.

We asked 20 habitually unshod or minimally shod Daasanach adults to walk across a pressure pad while carrying sandbags weighing 20% of their body weight in each of three configurations (at chest, shoulder, and head), and a control condition without weight. Pressure values were normalized relative to peak and an ANOVA was performed to test for differences under 1) corresponding metatarsal heads of the left and right feet; 2) each metatarsal head of the control condition, and the corresponding zones of the same foot in carrying conditions. In each condition, plantar pressure distribution under left and right feet were distinct from one another, with the fewest differences observed when head carrying. Furthermore, shoulder carrying produced the greatest differences in pressure distribution from the control under metatarsals 1, 2, and 5. We hypothesize that carrying may similarly affect external foot motions and may be recognizable in fossil footprints.

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### Estimation of the endocranial capacity of the Sima de los Huesos hominins

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Endocranial capacity is an important parameter in the study of human evolution. We undertook a scaling procedure using virtual endocasts in the two complete crania (Cranium 4 and 5) from the Sima de los Huesos sample to estimate endocranial volume in fourteen additional crania from this site. Fifteen endocranial landmarks were located on the endocasts in Cranium 4 and 5. These same landmarks were located on the less complete endocasts, and Cranium 4 and 5 were scaled until the location of the homologous points matched those preserved on the incomplete specimens. The endocranial capacity was then estimated in the incomplete specimens as the average of the two estimates based on Cranium 4 and 5. Importantly, Cranium 4 and 5 represent individuals at the small and large ends of the variation within the SH sample, thus controlling for any potential size-related effects in the scaling procedure. We tested the accuracy of this technique in reconstructing the cranial capacity of the nearly complete Cranium 6. The mean of the two endocast scaling estimates (1225 cm<sup>3</sup>) is nearly identical to the volume measured with millet seeds (1220 cm<sup>3</sup>). The endocranial volume estimates for the SH sample (n = 16) ranged from 1057 cm<sup>3</sup> (Cranium 11) to 1437 cm<sup>3</sup> (Cranium 13), with an average capacity of 1237 cm<sup>3</sup>. The mean value for the sample is clearly above the Asian *Homo erectus* mean, but below the Neandertal and Pleistocene *H. sapiens* means. The resulting encephalization quotient for the SH sample ranges from 3.76 - 4.01.

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### Adrenal development and androgen-immune interactions in orangutans (*Pongo pygmaeus morio*)

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Humans, chimpanzees, and bonobos exhibit a similar pattern of adrenal development, with adrenal androgens exhibiting a sharp increase in adolescence. Like testosterone, these adrenal androgens play an important role in modulating physiology, but specific associations between immune function and the adrenal androgens dehydroepiandrosterone (DHEA) and dehydroepiandrosterone-sulfate (DHEA-S) are

poorly understood, particularly in nonhuman primates for which there are few methods of non-invasive assessment of immune activity. The existence of adrenarche in orangutans has not been assessed, and there are few studies examining variability in immune function in this species. To remedy these deficiencies, sera were collected from orangutans (*Pongo pygmaeus morio*) (N = 38) at the Sepilok Orangutan Rehabilitation Centre, Sabah, Malaysia, during routine health screenings. Two measures of functional innate immunity (using a bacteria killing assay and a hemolytic complement assay) were compared to the androgens testosterone, DHEA, and DHEA-S. DHEA-S concentrations demonstrated elevations in adolescent animals in a pattern very similar to other apes. Additionally, while DHEA concentrations were higher in animals with high levels of serum bacteria killing ability, DHEA-S and testosterone were elevated in animals with reduced complement protein activity. These results suggest a differential role for androgens in influencing innate immune activity, and in particular an important role for DHEA and DHEA-S in influencing immunity. These results also are the first to suggest the presence of adrenarche in orangutans.

*This work was supported by Indiana University to MPM.*

### Mortuary archaeology of 87 Seventeenth Century burials from the Swahili stone town Mtwapa

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The Swahili coast of east Africa spans from Somalia to Mozambique, a stretch of almost 2000 miles of the east African coastline. While an understanding of Swahili customs is developing, there is a need for more data regarding the burial programs of the Swahili.

To such ends, the ancient Kenyan Swahili site Mtwapa was excavated over the course of four field seasons from 2008-2011. Mtwapa (ca. 1000-1750 CE), located on the southern coast of Kenya, was once a wealthy cosmopolitan polity involved in the Indian Ocean trade network. The town had a population of 5,000-10,000 at its height of occupation, and contained a large central mosque.

Mtwapa excavations occurred between 2008 and 2011 and produced a minimum of 87 individuals buried across 13 crypts in the cemetery located next to the central mosque, with an average of 7 individuals per crypt. Samples from 18 individuals were C14 dated to circa 1647 CE. Crypts contained both men and women, as well

as children. All individuals uncovered were lain on their right side, extended, facing mecca.

### Engaged Anthropology: Engaging Local Stakeholders and Decision Makers in Science and Conservation

JILL D. PRUETZ. Anthropology, Iowa State University.

After receiving Wenner-Gren (WG) funding to study chimpanzees (*Pan troglodytes verus*) in Senegal, I was awarded an Engaging Anthropology grant by this foundation to facilitate sharing my results with interested parties. In 2013, at the first of two meetings I proposed, over 35 participants representing other researchers, NGOs, local government, mining corporations, Senegalese National Parks, Universite Cheikh Anta Diop (Dakar), and the Senegalese Forestry Department met in Senegal for a successful informational meeting. A second meeting is scheduled for 2015, geared specifically to conserving chimpanzees. One participant, the African Wildlife Foundation, will help finance the second meeting and was instrumental in bringing GRASP (Great Apes Survival Partnership) to the table, which will also help fund this event. Our first meeting was highly successful in initiating discourse between international researchers, NGOs, and the wildlife community in Senegal in a more productive fashion than the largely one-on-one manner in which it was conducted previously due largely to a lack of resources. I view this as one step towards a more collaborative working relationship among all entities involved and one that will hopefully result in involving more Senegalese students in research. One of our ultimate goals is to design a strategic conservation plan for chimpanzees in Senegal given increasing mining activity. Thus, a relatively small investment from granting organizations can have a significant impact on collaboration between field researchers and local stakeholders at various levels. I will discuss lessons learned as well as positive outcomes from this process.

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### The first major primate extinction: Testing competitive exclusion in the fossil record of North American stem primates using dental topography

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The disappearance of North American Plesiadapidae and Carpolestidae, families in the “plesiadapiform” (=probable stem-primate) superfamily, Plesiadapoidea, is often attributed to competition with rodents. This study uses dental topographic metrics to investigate similarities and differences in molar morphology between plesiadapoids and rodents. Variation in dental topography should correlate with stress environment involved in interactions between tooth and food, which in turn should have an interaction effect with food physical properties. Micro-CT scans of 194  $M_2$ s of plesiadapoids and rodents were evaluated using Dirichlet Normal Energy, Relief Index, and Orientation-Patch-Count-Rotated. Comparisons of dental topographic metric values for plesiadapoids and rodents show that rodents shared functionally similar dental morphology with at least some plesiadapids, and thus likely processed foods with similar physical properties. However, the values for rodents contrast markedly with those for Carpolestidae and the third plesiadapoid family, Saxonellidae. As such, it is seems less likely that competition with rodents played a major role in the extinction of these families, as members were capable of utilizing a range of foods that were not accessible to rodents. The plesiadapid *Chiromyoides* is the only plesiadapid to exhibit dental topographic scores entirely within the range of rodents, and was therefore capable of processing foods most similar to the types of foods exploited by rodents. *Chiromyoides* is therefore the plesiadapoid most likely to have been in direct competition with rodents for food resources, and the most susceptible to extinction by competitive exclusion.

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#### The influence of diet on aggression and locomotion in *A. palliata* and *C. capucinus* in Costa Rica

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Diet has cascading effects on primate life, influencing competition, dispersal patterns, and social dominance. The largely fruit-based diet of *Cebus capucinus*, for example, leads to contest competition and dominance hierarchies, whereas the folivorous diet of *Alouatta palliata* evokes scramble competition and more relaxed dominance. Diet also likely influences locomotor patterns due to the distribution of preferred food items. In this study we examined variation in aggression and locomotor strategies between *C. capucinus* and *A. palliata* in La Suerte, Costa Rica. We predicted that *C. capucinus* would display higher rates of aggression than *A. palliata* due to the former's stricter dominance

hierarchies. We also predicted that *A. palliata* would bridge more frequently in the canopy than in any other layer because that is where leaves are most abundant, while *C. capucinus* would leap and travel more frequently in the understory layer where fruit is abundant. In May-June 2014, we conducted instantaneous scan sampling of adult males, during which we collected data on locomotion type and forest layer. We also recorded all occurrences of aggression on an ad libitum basis. As predicted, *C. capucinus* displayed rates of aggression three times higher than those of *A. palliata*. Furthermore, *A. palliata* bridged significantly more in the canopy and emergent layers than the lower levels of the forest, while *C. capucinus* leaped significantly more and spent more time in the understory layer compared to other forest levels. These findings suggest that diet likely contributes to both aggressive behavior and locomotor strategies in both species.

#### Phylogenetic relationships of living and fossil African papionins: combined evidence from morphology and molecules

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African papionins are a highly successful subtribe of Old World monkeys with an extensive fossil record. On the basis of both molecular and morphological data, crown African papionins are divided into two clades: 1) *Cercocebus* + *Mandrillus* and 2) *Lophocebus* + *Papio* + *Rungwecebus* + *Theropithecus*. Phylogenetic relationships among taxa in the latter clade remain equivocal, though the addition of the recently discovered *Rungwecebus* has provided some support for the hypothesis that *Theropithecus* is the basal taxon within this clade. While previous phylogenetic studies have focused on either molecular or morphological data, here African papionin molecular and morphological data were combined using both supermatrix and molecular backbone approaches. Fossil taxa were included in both analyses to explore relationships between fossil and extant taxa as well as increase phylogenetic resolution among living taxa. Gaps in molecular sequences, produced during multiple sequence alignment where insertions or deletions have occurred, were treated both as missing (“?”) and as a fifth character state. Results support *Theropithecus* as the sister taxon to *Lophocebus* + *Papio* + *Rungwecebus* (*L+P+R* clade). However, the topology of the *L+P+R* clade differs markedly among analyses and with different treatment of gaps. In particular, the supermatrix analysis with gaps scored as a fifth character state suggests *Papio* and *Lophocebus* are paraphyletic and that *Rungwecebus* is nested within a clade composed of members from both taxa. These results indicate that gaps may be phylogenetically

informative for these populations and that hybridization within the *L+P+R* clade is potentially more widespread than previously thought.

#### Analyzing the Form and Function of the Hominoid Scapula: a Morphometric and Biomechanical Approach

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Primate movements are complex, exhibiting an impressively large locomotor repertoire. This locomotor complexity relies on the primate strong hind limbs and their mobile forelimbs. The overall mobility of the forelimb depends on the structure and function of the shoulder region. Consequently, the evolution of shoulder mobility is one of the important evolutionary processes generating the locomotor diversity of primates. The latter is especially relevant among hominoids because within Hominoidea five divergent locomotion modes and associated body plans have evolved. The present study has analyzed how the form of the scapula is related to locomotor function in apes using a comparative framework. The scapulae were scanned and each dataset was used to perform finite element analysis. Two different loading scenarios were applied to simulate quadrupedalism and bimanual suspension. The obtained strain and stress values were collected at different locations as measurement of biomechanical performance. On the same specimens, several landmarks were registered in order to perform geometric morphometric analyses. The relationship between biomechanical performance and shape was analyzed by means of phylogenetic regressions. It was found that both shape and biomechanical performance are significantly related and that both have significant phylogenetic signals. When phylogenetic changes are adaptive, environmental components of variation are identical to phylogenetic components. Hence it seems that the hominoid scapular morphology is a product of adaptive processes. These results are expected to contribute when reconstructing the possible locomotor repertoires of extinct primate species and to appreciate the locomotor diversity observed in extant apes.

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#### Tanning persistence is associated with Indigenous American ancestry in Mexican Americans

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Dermatological research has been disproportionately focused on individuals of European ancestry resulting in medical advice and tests of questionable generalizability. Researchers throughout Central and South America and those working with Hispanic populations in the U.S. have noted that the assumptions about the relationship between basal pigmentation (BP) and tanning response as embodied by the Fitzpatrick skin typing scale are particularly problematic. This study investigates the hypothesis that individuals with a greater proportion of Indigenous American biogeographic ancestry (BGA) will show a stronger and more persistent tanning response than those with primarily European BGA.

107 self-identified Mexican or Mexican-American volunteers contributed DNA samples and had 2cm regions of previously unexposed skin exposed to controlled measures of UVR. Erythema (reddening) and melanogenic (tanning) response were measured at 24 hours, and 1 and 4 weeks after initial exposure. BGA was estimated in STRUCTURE from a panel of approximately 500,000 SNPs.

BP, a strong predictor of minimal erythema dose (minimum exposure causing reddening at 24 hours) and minimal melanogenic dose (minimum exposure causing melanogenesis at 7 days) in European-American populations, shows weaker predictive capacity in this Mexican-American sample (Pearson's correlations = 0.32, 0.28). The majority of the relationship between BGA and MMD/MED is mediated by the relationship between BP and BGA. However, persistence of tanning after 30 days is associated with greater Indigenous American BGA, an observation that remains after adjusting for BP. This finding provides preliminary support for differential response to UVR between individuals of Western European and Indigenous American ancestry.

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**Continued costs: postnatal maternal costs associated with breastfeeding and potential maternal strategies**

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The maternal costs of lactation far exceed those of gestation. Despite the considerable energetic burden imposed by lactation on mothers – both human and non-human – lactation remains an important part of mammalian infant development. Milk is highly evolved, with species specific traits and aspects that reflect ecological pressures or behavioral differences for that species. Human milk is no exception: compared to the milk of other mammals it is a typical, dilute primate milk with relatively little

fat and a lot of sugar, the ideal milk for a high contact species.

However, milk is not simply nutrition, but is a living substance containing probiotics, hormones, immunoproteins, oligosaccharides, and even stem cells. Although there is good evidence for maternal buffering of macronutrients, many of the hormones in milk are correlated with maternal body composition, especially adiposity. Many of these hormones show evidence for biological activity in infants, and are thought to play a role in the regulation of postnatal growth.

Elsewhere, it has been suggested that maternal body composition and metabolism may orchestrate optimal growth trajectories for infants, balancing maternal metabolic costs of lactation with both ecological pressures and resources available to support infant growth outside of lactation. However, little is known about these associations in populations with nutritional stress. Emerging evidence from these populations suggests that very low levels of maternal adiposity may actually promote infant growth, possibly allowing mothers to absorb growth costs and maximize infant ecological fitness.

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**The effects of pregnancy on gait mechanics: interpretations of skeletal material**

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It is widely assumed that the demands of gestation have profound effects on bone health and strength. High demands for calcium provision are placed upon the mother to ensure optimal fetal skeletal mineralization without compromise to maternal bone strength during an increased load-bearing period. However, few studies have examined the longitudinal effects over a complete reproductive cycle on locomotion and musculoskeletal anatomy. Our study compared pregnant CD-1 mice and SD rats with aged-matched nulliparous controls to test the effects of increased load-bearing changes on gait patterns and bone strength. Rodents were video recorded every other day for 19 days while walking freely across a force platform. Temporal gait parameters, speed, and peak vertical ground reaction forces (GRFs) were collected. Animals were injected with three fluorochrome dyes every 6 days to identify new bone growth. Following the experiment, the rodents were micro-CT scanned and bones from their hind and forelimbs were prepared for histological analysis. On average the pregnant rodents gained 35-40% of their initial body mass, while the controls gained up to 5%. Pregnant animals had an overall increase in GRFs for both limb pairs

compared to controls. Interestingly, the rats' hind limb forces increased significantly as pregnancy progressed ( $p < 0.05$ ), while the mice kept significantly higher forelimb peaks throughout gestation. These unexpected differences in limb loading patterns matched with the fetal skeletal mineralization demands on the mother, caution the reliability to infer behaviors from bone during the reproductive cycle.

**Smaller posterior semicircular canals are associated with leaping in *Colobus***

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The semicircular canals of the inner ear are the organ of balance, tracking head rotation during movement and facilitating reflexive stabilisation of vision. Morphological characteristics of the canals have been correlated with agility scores based on multiple measures of behaviour. To date, however, the relationship between semicircular canal morphology and specific locomotor behaviours, such as leaping, is unknown. Knowledge of such a relationship could strengthen the inferences of locomotion of extinct taxa beyond agility, as the semicircular canals are preserved in fossils.

To test this, the crania of closely related primate species (*Colobus guereza* and *C. polykomos*) differing in the percentage of leaping in their locomotor repertoire were examined using microscopic computed tomography ( $\mu$ CT). Three-dimensional virtual models were derived using the software package AVIZO, and two measurements (mean canal radius of curvature and enclosed planar area) of each of the three canals were measured relative to two cranial size proxies.

While 'agile' species have larger anterior canals, there was no corresponding significant difference between *Colobus* spp. Instead, the 'leaping' form (*C. guereza*) possesses significantly smaller posterior canals. This may be related to the need for leapers to recover balance quickly upon landing. While this difference suggests a method by which specific locomotor behaviours can be inferred for extinct primates, what remains unclear at present is whether this phenomenon is applicable outside the genus examined. The authors are currently extending the study to other pairs of taxa that also differ in the amount of leaping in their locomotor repertoire.

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### Reconstructing the Effects of European Contact on North Slope Iñupiat Populations through Genetic, Archaeological, and Ethnohistoric Research

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When the HMS *Blossom* landed at Point Barrow, Alaska in 1826, it initiated the first European contact with the Iñupiat peoples of the Alaskan North Slope. In the years that followed, commercial, scientific, and religious expeditions brought increasing numbers of outsiders to the region, with some visiting transiently and others settling permanently in Iñupiat communities. Recent genetic studies of these communities have investigated the prehistory of the North American Arctic, but considerably less attention has been paid to this more recent history — particularly the genetic impact of these interactions between Iñupiat populations and outsiders.

Here, we discuss the results of a multidisciplinary study of the effects of this contact. Using SNP arrays and next generation sequencing, we collected genome-wide data from consenting participants in eight communities of the Alaskan North Slope. We investigated the demographic effects of admixture and changes in population size after contact across the North Slope, as well as within individual Iñupiat communities. We found evidence of demographic shifts and extensive male-mediated European admixture in these populations. By integrating these genetic data with archaeological, historical, and ethnographic information about changes to settlement patterns, subsistence practices, and economic activities (particularly whaling) after contact, we constructed a detailed picture of the post-contact history of these North Slope communities. Together, these multiple lines of evidence provide a rich understanding of the process and impact of contact in this region.

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### Cultural Interaction and Biological Distance in Postclassic Period Mexico

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Economic, political, and cultural relationships connected virtually every population throughout Mexico during Postclassic period (AD 900-1520). Much of what is known about population interaction in prehistoric Mexico is based on archaeological or ethnohistoric data. What is unclear, especially for the Postclassic period, is how these data correlate with biological population structure. We address this by developing biological (phenotypic) distances among 28 samples by comparing frequencies of dental morphological traits, which serve as a proxy for genetic variation, from 810 individuals. These distances were then compared with models representing geographic and cultural relationships among the same groups. Using Mantel matrix correlation tests, our results show that geographic distance and shared migration, trade, and shared cultural group are correlated with biological distances, but political interaction is not. Trade and political interaction are correlated with biological distance when combined in a single matrix. When similarities among variables are controlled using partial Mantel tests, shared migration, trade, and cultural group remain correlated with biological distance. The results of this study show that trade relationships affected population structure among Postclassic Mexican populations, and as such suggest that trade likely played a major role in shaping patterns of interaction between populations. This study also shows that the biological distance data support the migration histories known through ethnohistoric sources.

### Asymmetry of the endosteal lamellar pocket and cross-sectional properties in the human second metacarpal

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Previous studies have hypothesized that the endosteal lamellar pocket (ELP), primary circumferential lamellar bone remaining from bone modeling, could be a functional adaptation to mechanical load changes during growth. Accordingly, we would expect ELP to be larger on bones that incurred larger loads. We test this hypothesis by comparing the asymmetric expression of the ELP to the asymmetry of cross-sectional properties in the human upper limb. More specifically, this study tests whether right-left asymmetry of ELP area is correlated with asymmetry in bending rigidity measurements ( $I_x$ ,  $I_y$ ,  $I_{max}$  and  $I_{min}$ ), polar moment of area ( $J$ ) and total and cortical areas (TA, CA). Our sample consists of right and left second metacarpals from two populations: Eurocanadian settlers ( $n=22$ ), from a cemetery active between 1821 and 1874, and Sadlermiut Inuit from the Central Canadian Arctic proto-historic period ( $n=10$ ). In order to evaluate the asymmetric relationship, we

calculated the % right-left differences for each variable and tested for correlations between ELP and macroscopic measurements.

No correlation was found between ELP area and cross-sectional properties. However, when populations were analyzed separately, the Eurocanadians sample showed a significant ( $p<0.05$ ) correlation between asymmetries of ELP and CA ( $R=0.48$ ), and  $I_{min}$  ( $R=0.54$ ), but when Bonferroni's correction was applied to control for the number of tests performed, no results were significant ( $p<0.007$ ). This preliminary study does not support the hypothesis that ELP is principally deposited to meet changing biomechanical loads in the second metacarpals, but rather, suggests that ELP is the result of a natural growth process.

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### The phylogenetic position of *Homo heidelbergensis*

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Many European specimens (but others as well) have been gathered into the hypodigm of *H. heidelbergensis* more because of their geological age than their anatomy. The old geological age of the Mauer mandible and its supposed primitiveness were seen as evidence of the specimen's role as a link in the evolutionary chain leading to modern humans. Also, according to some researchers, the specimen's alleged similarity to *H. neanderthalensis* suggests that the specimen is part of the Neandertal clade.

However, our analysis of the Mauer mandible and its comparison with other mandibles show that the Mauer specimen is one of a kind. The unique morphology of the superior end of its ramus stems primarily from the immense breadth of the ramus and the relationship between the heights of the coronoid process, the deepest point of the mandibular notch, and the condyle.

The mandible does not resemble that of Ternifine 3 nor other specimens that some regard as *H. heidelbergensis*, including the mandibles from Arago and Sima de los Huesos. The specimens from these two sites bear some manifestations of Neandertal anatomy that we argue are lacking in the Mauer mandible.

With its highly derived anatomy, the Mauer mandible represents a clade of its own. Arguably, this species is too specialized to serve as an ancestor of either modern humans or Neandertals.



### Studying modern human migrations with integrated analyses of genetic and linguistic data

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Patterns of genetic variation are driven by human demographic history, but it remains unknown whether similar patterns are observed in linguistic traits such as phonemes - sound units that distinguish meaning between words in languages - on a global scale. Here we analyze, jointly and in parallel, phoneme inventories from 2082 worldwide languages and microsatellite polymorphisms from 246 worldwide populations. On a global scale, both genetic distance and phonemic distance between populations are significantly correlated with geographic distance; also, languages in geographic proximity share more phonemes, whether or not they are closely related. We find the axes of greatest linguistic differentiation within geographic regions correspond to axes of genetic differentiation, suggesting that there is a relationship between human dispersal and phonemic variation. However, we do not find evidence that phonemes retain a signal of human expansion out of Africa. Further, although geographically isolated populations lose genetic diversity via genetic drift, we find that drift in phonemes across worldwide languages may not operate in the same manner: within a given geographic radius, languages that are relatively isolated are more susceptible to change, including gaining phonemes, than languages with many neighbors. Within a language family, modeling phoneme evolution along either a genetic or Bayesian cognate-based linguistic phylogeny predicts similar ancestral phoneme states to those predicted from ancient sources. These analyses join a long tradition of interdisciplinary studies underscoring that collaboration between geneticists, linguists, and anthropologists will deepen our understanding of human evolutionary history.

### Estimates of fossil hominin quadriceps physiological cross sectional area from patellar dimensions

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Many aspects of limb function, including strength and fatigue resistance, are determined by muscle dimensions. Reconstructions of fossil hominin locomotor abilities are hampered by a lack of reliable methods for estimating muscle dimensions from skeletal elements. Here, we test whether the patella, a sesamoid bone of the quadriceps complex tendon, is a reliable indicator of physiological cross-sectional area of the quadriceps muscle group. We examined the relationship between linear dimensions of the patella and the physiological cross-sectional area (PCSA) of the quadriceps muscle complex in hominoids (*Hylobates*, *Nomascus*, *Symphalangus*, *Pongo*, *Gorilla*, *Pan*, and *Homo*), a strepsirrhine (*Lemur fulvus*), a common European rabbit (*Oryctolagus cuniculus*), and a common housecat (*Felis catus*). We calculated patellar cross-sectional area in two planes: sagittal (the product of anterior-posterior thickness and superior-inferior height), and transverse (the product of anterior-posterior thickness and mediolateral width). Both the sagittal plane cross-sectional area (SCSA) and the transverse plane cross-sectional area (TCSA) were significantly correlated with the PCSA of the quadriceps complex ( $P < 0.001$  for both;  $r^2 = 0.99, 0.97$  respectively), independent of osteological indices of body size (e.g., femoral head dimensions). These relationships across the primate and greater mammalian sample provide a new approach for reconstructing locomotor performance and ecology in extinct taxa where the patella is preserved. Estimates of fossil hominin PCSA from the SCSA and TCSA regressions suggest an increase in quadriceps size beginning in the genus *Homo*.

### Correlations among morphoscopic traits in peoples of the Pacific

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It has long been understood that a vast amount of biological variability exists in groups of the Pacific. Differential founding populations and recent gene flow have helped to create this interesting dynamic of variability. To better understand these populations and their associations with one another, data were collected using Osteoware for sixteen morphoscopic traits from the Smithsonian National Museum of Natural History and the University of Pennsylvania Museum of Archaeology and Anthropology. Populations from which data were collected include several countries in Island Southeast Asia, Melanesia, and Polynesia. Pearson's correlation coefficients were calculated to determine if certain expressions of traits correspond to any other trait expressions. Ten trait pairings expressed a significant correlation and seven of these trait pairings, as well as one uncorrelated pairing, were chosen for closer examination for this presentation. Multiple correspondence analyses

were performed and plots produced for correlations between the interorbital breadth and nasal aperture width (n=149), inferior nasal aperture and anterior nasal spine (n=153), posterior zygomatic tubercle and zygomaticomaxillary suture course (n=130), nasal bone contour and nasal overgrowth (n=110), nasal bone contour and interorbital breadth (n=133), nasal bone contour and anterior nasal spine (n=123), nasal bone contour and inferior nasal aperture (n=133), and nasal overgrowth and postbregmatic depression (n=113). These analyses show relative similarity of trait correlation between Melanesians and Island Southeast Asians on all trait pairings while the trait correlations of Polynesians remain less similar. These results provide support for previously presented research among the groups of the Pacific.

### Developmental Tradeoffs of the Dental and Skeletal Systems

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The extended duration of development and its influence on human life history is a defining characteristic of humans. For this reason, plasticity in development between body systems offers insight into the evolutionary history of humans. Unfortunately, much of the research that has been done comparing skeletal and dental development has been conducted by orthodontists, and as such, has focused on correlations between the two systems during late childhood and early adolescence. By focusing on this period, the earlier developmental tradeoffs that occur between these two systems are ignored, phenomena of interesting to anthropologists. This longitudinal pilot study examines the strength of correlations between these two systems during development, focusing on girls of European American ancestry from the Bolton-Brush Growth Study Collection at 3, 6, 9, and 12 years of age (N=50). Dental and skeletal development was scored at each age from radiographs using atlases of dental and hand-wrist development. General linear models were run comparing the two systems, both by age and overall. Considering all ages together, there is a strong positive correlation in development of the two systems ( $P < 0.001$ ). This is expected, given the cumulative nature of development over age. At age 12 the systems also demonstrated significant correlation, in agreement with previous studies. However, at ages 3, 6, and 9, correlations between dental and skeletal development are not significant. This suggests that the tradeoffs that occur between the two systems change as an individual approaches puberty.

### Got a bone to pick? Functional implications of intracranial variation in osteoblast behavior

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Non-sutural bone formation in the developing mammal skull is poorly understood, which limits progress understanding the function and evolution of the feeding apparatus and neurocranium. This is complicated by the fact that craniofacial osteoblasts vary with respect to embryological precursor (neural crest/paraxial mesoderm), ossification mode (intramembranous/endochondral) and peak load (high/low strain). Thus, identifying the mechanobiology of non-sutural osteoblasts from different skull locations has wide-ranging implications for improved characterization of regional variation in cranial development and functional determinants of morphological variation in living and fossil taxa.

The goals of this study are to: 1) develop a procedure for the isolation of non-sutural murine osteoblasts from the calvarium, basicranium and mandible; 2) evaluate the inherent osteogenic potential of isolated osteoblasts in 3D micromass culture; and 3) investigate if embryological origin affects osteoblast response to mechanical loading. To this end, osteoblasts were isolated from neonatal ICR mice via collagenase and outgrowth methods. Cultured osteoblasts displayed site-specific variation with respect to proliferation, alkaline phosphatase activity (a marker of bone formation) and biomineralization potential. Interestingly, equibiaxial tensile strain differentially affected expression patterns of calvarial osteoblasts arising from different embryological origins. Our research suggests that non-sutural cranial osteoblasts are not a homogeneous group of cells, but rather exhibit distinct behaviors depending on their anatomical location and embryological origin. Such novel findings are critically important for highlighting why bone should not be viewed as similar across skeletal regions with respect to its intrinsic growth potential or vis-a-vis extrinsic loading stimuli, an assumption inherent to most comparative studies.

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**The educational importance of comedy in biological anthropology, one humerus pun at a time**

NATALIA A. REAGAN. Chief Creative Officer, BOAS Network.

Anatomically modern humans (*Homo sapiens sapiens*) share distinct universals that span multiple cultures. These universals include play, jokes, aggression, and cooperation. The universal that is the basis of this talk is 'jokes', which depending on their effectiveness, can lead to any of the former universals. Biological anthropology is rife with comedy. Not only are jokes spawned by biological anthropologists for the amusement of their colleagues, these jokes are effective teaching mechanisms that allow students to fully connect with the material. Paleoanthropologist Zach Throckmorton, who specializes in hominin foot evolution, is certainly in step with utilizing jokes in his lectures. On the heels of his book entitled "Anthro 404: Funny not Found," Throckmorton's upcoming paper title "The gripping tale of Gantzer's muscle" is armed with multiple puns. Talk titles are an example of how anthropologists can stretch their funny bone while remaining 'legitimate' in their scientific community. Molecular anthropologist Todd Disotell eliminates the need to be overly serious with his exceptional use of punning in "Waste is a terrible thing to mind: The extraction of DNA from feces". Lactation specialist Katie Hinde has taken to the internet as a whey to connect to a wider audience. She milks the humor from her research with her blog, "Mammals Suck". Employing these tactics allows biological anthropologists to successfully engage with students, which is crucial to their role as educators. Therefore this talk aims to awaken the 'punnist' within, offer suggestions for extracting humor from your research, all the while sharing patella-slapping examples.

### Cercopithecine forelimb locomotor adaptations: 3D geometric morphometric analysis of modern and fossil monkeys from the Hadar and Middle Ledi sites, Afar Region, Ethiopia

AMY L. RECTOR. Anthropology Department, Virginia Commonwealth University.

Understanding how fossil mammals used their environments is key to reconstructing paleohabitats. Since most large mammal fossils are recovered as isolated postcranial elements, methods of reconstructing behaviors using ecomorphological indicators are often necessary. For hominin-bearing fossil localities, these types of analyses are especially important for reconstructing the ecological parameters of the paleocommunity within which hominins adapted and evolved through time. Cercopithecinae are of particular interest when reconstructing hominin paleoenvironments because they represent the majority of non-hominin primates recovered from many east African localities.

The current study applies 3D geometric morphometric analyses to the distal humeri and

proximal ulnae of a sample of >40 modern cercopithecine species with varying locomotor habits to differentiate morphology associated with locomotor behavior and substrate use. The multivariate analyses quantifying modern variation were then used to retrodict locomotor behaviors of more than 60 isolated fossil monkey elements from the Hadar and Middle Ledi fossil localities with whom *Australopithecus afarensis* shared environments.

Results of PCA and DFA suggest that morphology of the distal humerus and proximal ulna can be successfully used to distinguish arboreal, terrestrial, and mixed arboreal/terrestrial substrate use in modern cercopithecine primates. Further, the variation in these elements can be applied to categorize likely substrate use of fossil monkeys. The fossil primate communities of Hadar and Middle Ledi are reconstructed as significantly terrestrial. *A. afarensis* 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.

### Lemurs Do Not Yawn Contagiously

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Among some haplorhine primates, including humans, yawns spread contagiously. Contagious yawning is linked to social bonds and empathy in haplorhines. However, no studies have investigated contagious yawning in strepsirhines. We conducted an experimental study of contagious yawning in strepsirhines, testing ruffed lemurs and ring-tailed lemurs (n=24) at the Duke Lemur Center in a paradigm similar to one that has induced contagious yawning in haplorhines. First, on separate testing days, while individual lemurs were in their home enclosures but temporarily separated from groupmates, we showed them life-size video projections of groupmates and strangers yawning, and control footage of the same individuals at rest. Subjects did not yawn in response to any footage. To examine whether a group context might enhance, or allow for contagion, we next exposed subjects to the same videos but presented them to the entire group at once. Again, lemurs did not yawn in response to the footage. In a follow-up control study, we investigated whether lemurs responded to video content in general. While lemurs remained with their groupmates, we showed them two videos to which we expected them to produce different responses: one featured a predator, the other a lemur caretaker holding food. Lemurs produced alarm vocalizations and moved upward while viewing the predator, but not the caretaker, demonstrating that they do perceive video content meaningfully. This study

provides the first evidence that lemurs do not respond to yawning stimuli similarly to haplorhines, and suggests that the behavior evolved in haplorhines after the lineages split.

This project was supported by a Molly Glander Award from the Duke Lemur Center and the Duke Undergraduate Research Support Office.

**The effects of environmental conditions on the development of sexual dimorphism: a comparison of boys and girls from three Industrial European skeletal samples**

SARAH REEDY. Anthropology, University of MA, Amherst.

Exposure to poor environments, malnutrition, and labor during childhood can lead to stunted height and increased mortality. Studies of skeletal samples from Industrial Era Europe show that height is stunted when compared to Medieval samples, suggesting living conditions were more strained. Literature suggests that while poor conditions negatively impact all children, boys may be particularly disadvantaged, because girls can reserve nutritional components buffering them during times of stress.

This study examines skeletal growth in three Industrial European skeletal samples. Femur length was measured in known-sex juveniles (0-18 years) from low, middle, and high socioeconomic status (SES). I hypothesize that 1) femur lengths will be shorter when compared to a modern, healthy reference sample, and 2) boys' growth will be impacted more negatively than girls, resulting in lower sexual dimorphism, especially in lower SES samples.

Results show significantly shorter femora in all three samples, with stunting increasing throughout childhood, confirming the first hypothesis. Young boys (6-8 years) in middle and high SES samples exhibit more stunting than females ( $z$ -scores  $< 3$ ), and sexual dimorphism is not significant amongst any age group, with the exception of lower SES adolescents, supporting the second hypothesis. Boys in all samples, however, experience catch-up growth, while girls show significantly more stunting.

Evidence of catch-up growth in boys and not girls suggests gender preference with possible access to better foods and healthcare. Historical research of this time period does suggest that adolescent boys often received higher quality food than girls, supporting the results of this research.

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**Mixed signals: a comparison of sex determination ratios within and between bones in a fragmentary, commingled skeletal assemblage**

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Demographic analyses of commingled skeletal collections often do not permit the use of multivariate features for the same individual, or even the same bone. For the current study, we compared a variety of established and newer metric and non-metric techniques from the most well-preserved skeletal elements found in fragmentary, commingled assemblages. The collection utilized is from Byzantine St. Stephen's monastery in Jerusalem (5th-7th century AD), which benefits from a rich historical and archaeological record detailing the inhabitants of the site, and nearly 20 years of intensive analysis of the human remains from the site. We used sex determination methods from throughout the skeleton to compare the consistency of sex ratios using individual elements, as well as within the same bone types, to assess the use of alternative methods in the absence of other key diagnostic features. Methods utilized for within and between bone comparisons included: tibia [circumference at the nutrient foramen ( $n=65$ ), proximal bicondylar breadth ( $n=33$ )]; humerus [head diameter ( $n=38$ ), trochlea curvature and epicondyle angle ( $n=73$ )]; temporal bone [mastoid process robusticity ( $n=99$ ), circumference and angle of the petrous portion ( $n=65$ )]; femur [vertical head diameter ( $n=99$ ) and bicondylar breadth ( $n=85$ )]; mandible [gonial eversion ( $n=41$ ), mental eminence robusticity ( $n=52$ ), canine metrics ( $n=58$ )]. Although the collection demonstrated a preponderance of males, we found exceptionally high consistency in features within bone types, between metric methods, and between non-metric methods, but not when comparing metric and non-metric techniques (at  $p \geq 0.05$ ).

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**Life Expectancy Changes in the German Immigrant Population in Franklin County, Indiana: A Multigenerational Comparison**

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The new environment that immigrants encounter presents stresses and opportunities that can impact their overall health, sometimes for generations. The changing health of immigrant

groups gives insight into the response to environmental conditions into which they migrated. For historical populations, life expectancy is the most consistent measure of health available and may be readily used to compare populations. We examined the immigrant experience in 19th-century Franklin County, a rural community located in the eastern part of Indiana. Since the 1830's, it has had a large German-ancestry population. We compared the life expectancies of German immigrants, children of the immigrants and grandchildren of the immigrants. Comparison life expectancies were also calculated for the population of the county as a whole.

The German immigrants were found to have a life expectancy at age 30 that was almost 4 years greater than the children of immigrants, but more than 5 and a half years less than the grandchildren. In comparison, the countywide life expectancies were similar to the German immigrant population, higher than the children of the immigrants, lower than the grandchildren and did not significantly increase over time.

This study is a part of the Franklin County Demographic Project.

**Ulnar shape and locomotion in primates**

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Previous research on the long bones of the antebrahium has uncovered relationships between the form of these elements and locomotion. Variations in bone length, joint size, and joint orientation distinguish species that are adapted for different locomotor behaviors. These patterns of variation provide important insight into the behavior of extinct primate species, including early hominins. The objective of this study was to enhance our understanding of ulnar shape and locomotor adaptation. We examined the relationship between shape variables and locomotor behaviors such as arboreal quadrupedalism, semi-terrestrial quadrupedalism, and suspension. We also investigated how shape variables based on geometric morphometric analyses correlated with traditional interlandmark distances representing total bone length and joint size.

In order to achieve our research objectives, we examined both 3D landmark coordinate configurations and interlandmark distances collected on complete ulnae of 341 specimens of extant platyrrhines, cercopithecoids, and hominoids. We employed geometric morphometrics and regression analyses to assess



the correspondence between different variables. Our results show that shape variables based on geometric morphometric analyses indicate adaptation to suspensory behaviors as well as distinguish between arboreal and semi-terrestrial quadrupeds. These components of shape variation correlated with relative ulna length and joint size, but also incorporated other aspects of ulnar shape that resulted in a relatively strong relationship with forelimb-dominated suspensory movements. Despite the limited number of complete ulnae in the fossil record, our study illustrates the effectiveness of this approach for assessing the performance of these behaviors among extinct species.

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#### **Diet and Health in the North Carolina Piedmont**

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This study uses the dental and cranial skeletal remains of the North Carolina Piedmont populations from the archaeological sites of Town Creek, Forbush Creek, Early Upper Saratown (Hairston), Wall, Fredricks, and Upper Saratown to assess how agriculture and European contact influenced nutrition and overall health. The samples range from A.D. 700-1710, a period that encompasses a series of dietary transformations that include the increased incorporation of maize into the diet, and the arrival of Europeans into the area.

Oral health data were collected by observing the presence and number of carious lesions, alveolar infection, antemortem tooth loss, and dental calculus. Frequencies of porotic hyperostosis, cribra orbitalia, and scurvy were used as additional evidence of dietary deficiencies. The results of this study suggest a decline in health during the middle period of my sample (A.D. 1450-1620), when agriculture was the most dominant part of a subsistence economy. Furthermore, there appears to be a reduction in nutritional strain for populations with a more mixed economy in the late period of my sample (A.D. 1670-1710), a time associated with increased mobility and potentially less dependence on maize agriculture.

*The radiographs used in this study were made possible by the Michael P. and Jean W. Carter Research Fund at the University of North Carolina at Chapel Hill.*

#### **A new early modern human calvarium from Olduvai Gorge, Tanzania**

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Here we present the first description of a partial hominid calvarium, OH 83, found in 2009 on the north side of Olduvai Gorge at archaeological locality PLK by the Conservation Olduvai Project and excavated by the University of Dar es Salaam field school, both under the direction of F.T. Masao. The calvarium was recovered 180-220 cm below the surface of the exposed Ndutu Beds and derives from the upper unit. Dated to approximately 60-15 kya, this early modern human calvarium is mainly composed of the frontal and left parietal. In addition to collecting standard manual measurements, we photographed and 3D laser scanned the specimen at the National Natural History Museum, Arusha to facilitate digital measurement and morphological comparison. While incomplete, preservation is sufficient to assess frontal bone morphology and overall vault shape. Aspects of this calvarium including its high, vertically oriented forehead, and medially divided supraorbital torus are well within the range of morphological variation found in modern humans. Although some of the preserved morphological characters of this specimen, such as its long cranial vault and slight post-orbital constriction are similar to *Homo rhodesiensis*, the overall morphometric affinities of OH 83 are essentially modern. This specimen augments the African early human fossil record, providing additional information about the range of cranial variation of early humans.

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#### **Sex differences in activity patterns between wild and captive *Cebus* and *Alouatta***

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Male and female primates have different overall energy requirements. Adult females are affected by reproduction because it takes additional energy to gestate, lactate, and care for infants. Captivity also likely affects energy requirements due to readily available food sources and space constraints. We examined activity patterns with respect to energy requirements in wild and captive *Alouatta* and *Cebus*. Because females must conserve energy for reproduction, we

predicted that females of both genera would spend more time resting than males. We also predicted that captive females would spend less time foraging than wild females since the former are provisioned. We examined the activity budgets of *Alouatta palliata* and *Cebus capucinus* in La Suerte, Costa Rica during May-June 2014, and *Alouatta caraya* and *Cebus apella* at the Denver Zoo during June-August 2014. To assess activity patterns we used scan sampling of focal individuals, during which we recorded activity at 2-minute intervals. As predicted, female *A. palliata* and *C. apella* both spent more time resting than males. Female *C. capucinus* and *A. caraya*, however, spent less time resting than males which may be due to the fact that only one *C. capucinus* female was lactating and the captive *A. caraya* group is not currently a reproductive unit. Furthermore, wild female *Alouatta* did spend more time foraging than female *Alouatta* in captivity. However, captive female *Cebus* spent more time foraging than their wild counterparts. Captive *Cebus* may forage more as a means of enrichment due to limited space rather than to fulfill energy requirements.

#### **Comparative Perspectives on Subadult Dietary Variation in North-Central Poland, 10-19<sup>th</sup> c. AD**

LAURIE J. REITSEMA<sup>1</sup>, MAGDALENA KRAJEWSKA<sup>2</sup> and TOMASZ KOZŁOWSKI<sup>2</sup>. <sup>1</sup>Department of Anthropology, University of Georgia, <sup>2</sup>Department of Anthropology, Nicolaus Copernicus University.

We survey medieval and pre-modern dietary variation in ten settlement contexts from north-central Poland to understand daily lives of children and how they differed among sites and in comparison with adults. Rib collagen of 78 subadults (n=75 post-weaning) was assayed for stable carbon and nitrogen isotope data ( $\delta^{13}\text{C}$ ;  $\delta^{15}\text{N}$ ).

Results from church and cemetery contexts (both available at Gniew; Płonkowo) are not significantly different. Villages and towns do differ, with diets at more rural settlements (Gruczno, Kałdus, Kamionki Duże) typically comprising less animal protein than at towns (Toruń, Inowrocław, Gniew) ( $\delta^{15}\text{N}$ :  $p < 0.001$ ). Płonkowo is an exception where rural land-holding nobles and farmers associated with their manors exhibit high  $\delta^{15}\text{N}$  values (11‰+). Fish consumption appears highest at Inowrocław and Płonkowo, the two sites farthest from the Vistula River.

Isotopic data from adults are available for comparison from three of the sites, Kałdus Site 1, Kałdus Site 4, and Gruczno. Subadult and adult stable isotope values are similar, suggesting children did not receive special dietary consideration.

Samples span the 10-19<sup>th</sup> c. AD. Through time,  $\delta^{15}\text{N}$  values tend to increase ( $R^2=0.3116$ ) and  $\delta^{13}\text{C}$  values tend to decrease ( $R^2=0.1121$ ). We interpret this as increase in access to and exchange of animal protein through time, including freshwater fish, and perhaps increased focus on  $C_3$  cultigens at the expense of millet.

The tendency for rural elites, the farmers associated with their manors, and town-dwellers to consume similar high-protein diets points to the capacity of elites to stimulate general availability of high-quality food resources in stratified societies.

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#### **Association between culturally relevant measures of stress and telomere length**

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Telomeres are found at the end of eukaryotic chromosomes, shorten with age in proliferating cells, are associated with senescence, and change in length over the course of a life span in response to the environment, including oxidative damage caused by psychological and psychosocial stress. The idea that violence, social discrimination, and stress exposure can create changes in health outcomes, possibly through shorter telomeres, has immediate relevance to global public health issues.

Our study presents data measuring the effects of stress from the war in the eastern Democratic Republic of Congo (DRC) and from socioeconomic stress and racial discrimination in Tallahassee, FL by looking at telomere length (TL). By incorporating novel biocultural measures of stress gathered via comprehensive ethnographic interviews, we test the hypothesis that culturally relevant measures of stress are associated with shortened TL, which may in turn predict how an individual's environment affects their health. DNA was isolated from 200 whole blood samples and 100 placental samples from new mothers and babies in the DRC and from 178 saliva samples from Tallahassee study participants. Relative TL was measured via quantitative PCR analysis. Preliminary results from a subset of DRC samples show an association indicating that lower placental TL tends to occur with higher war stress exposure. This research has implications for understanding how telomere length may mediate the effect of the cultural environment on biological health.

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#### **Biological distances and population genetics in bioarchaeology**

JOHN H. RELETFORD. Department of Anthropology, State University of New York College at Oneonta.

The use of biological distance is common in studies of biological anthropology and bioarchaeology. This paper reviews the application of population genetic models for biodistances based on metric traits, outlining benefits and potential problems. A preferred measure of population affinity for metric traits has been Mahalanobis' distance, which takes intercorrelation of metric traits into account. An alternative approach in recent years has been to use biodistances based on R-matrix theory, based on the variance-covariance matrix of allele frequencies among a set of populations. R-matrix methods have been extended to metric traits by Williams-Blangero and Blangero and by Relethford and Blangero, among others. Biodistances based on R-matrix theory derive from the application of the equal and additive effects model of quantitative genetics. In addition to providing distances between pairs of populations, extensions of R-matrix theory allow estimation of other population genetic parameters, such as  $F_{ST}$  and patterns of residual heterozygosity and external gene flow. For many problems in bioarchaeology, using Mahalanobis' distance is sufficient, as it is directly proportional to R-matrix distance when population size is the same (or assumed to be the same) across all populations. Detailed analyses that rely on the model-bound estimation of population genetic parameters require additional assumptions that might not always be appropriate. Some potential problems include reading too much into  $F_{ST}$  and other population parameters, mixing local, regional, and continental populations, estimating biodistances across time periods, and assumptions regarding heritability.

#### **Individual, Observational, and Imitation Learning in Orangutans**

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Social learning results from exposure to others' actions and is evident in many animal species. To what extent does the channel of information (individual, nonsocial, or social) affect the retention and use of information by non-human primates? We utilized two analogous touchscreen tasks that involve touching three simultaneously presented pictures in a sequence. In the motor-spatial task, participants select three identical items based on their locations; in the cognitive task, participants select three different items based on their identities. Three orangutans

were given four conditions in which to learn a new sequence for each task: (i) trial-and-error (Baseline), (ii) Recall after a 30-second delay (using the same sequence as in the trial-and-error condition), (iii) "Ghost" (computer-only) demonstration, or (iv) human "Imitation" demonstration. Apes were trained to criterion on two-item lists, and subsequently completed 48 different three-item lists in each condition. Performance as measured by Trial 1 accuracy using the binomial test was significantly better than chance (16.7%) only in the Recall condition of the cognitive task for two orangutans and in the Recall condition of the motor-spatial task for one orangutan. Performance in the Baseline, Ghost, and Imitation conditions did not exceed chance levels for both tasks. These results indicate that great apes perform best when engaging in individual learning (the Recall condition). While great apes can learn various behaviors from other individuals, they do not appear to do so in a task that requires high-fidelity copying.

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#### **Hips don't lie: A multivariate approach to hominid sex determination from the pelvis**

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Summary Sex is a multivariate quantitative approach being developed for sex estimation in modern humans. It uses nine nonmetric pelvic indicators scored along an ordinal scale that is then subjected to a Principal Components Analysis. The First Principal Component (PC1) orders the specimens from most female to most male; that is, PC1 is Summary Sex. The primary reference population for Summary Sex was the Georgian/Victorian Spitalfields named-collection housed at Natural History Museum, London (N=138).

We have begun a preliminary exploration of applying Summary Sex to fossil human ancestors and extant Great Apes, with data collected thus far from casts, published images, and skeletal material of the apes. Because many of the specimens were fragmentary, the median score of the known indicators for each individual was used for any missing indicators. PC1 explained 64.22% of the total variation and Summary Sex correctly identified sex with an accuracy of 93.75% (with only one misclassification of a female *Gorilla gorilla*). The analysis was run a second time using the equation extracted from only the primary modern human sample with the same classification results. This is perhaps a

surprising result for earlier human antecedents that predate brain expansion.

#### Between the Lines: Interpreting Disparate Data in Castration Studies

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Castration is a wide-ranging social phenomenon that has greatly impacted human history, but its modern, systematic study has been patchy, especially in the medico-anthropological fields. This project was designed to identify the changes in the human male skeleton caused by prepubertal castration and bring them to the attention of modern palaeopathologists. In this study, social, historical, and anthropological data illuminated the daily lives and status of castrates within multiple societies. Historical and archaeological data determined the most likely places in which castrate burials and skeletons might be found. Historical, medical, and palaeopathological data gave insight into the changes to expect in a prepubertally castrated skeleton. Conversion formulae were created to combine osteometric and anthropometric data. This was then analyzed and compared to zooarchaeological data to determine the changes to the mammalian skeleton most likely to be caused by prepubertal castration. Statistical methods were used to detect castrate presence within skeletal assemblages, and a new palaeopathological checklist of castration traits was created to aid in the identification of castrate skeletons. Castrate bodies within the skeletal record represent a group of archaeologically invisible intersex individuals who had a great impact upon human history. Identifying intersex bodies within archaeological skeletal assemblages is important not only for historical purposes, but for tracing the history of conditions which affect considerable portions of the human population today. The methods used to combine data within this study can be used to identify other intersex individuals, broadening our understanding of human skeletal and sexual diversity through time.

#### Gray matter in the left inferior parietal cortex is expanded in chimpanzees with greater skill at tool-use

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Evidence from paleoneurology and neuroimaging studies suggests that the inferior

parietal lobe (IPL) expanded in the hominin lineage. The IPL is part of the mirror neuron system, which is active during tool-use and tool-making. We compared gray matter distribution in MRI scans of skilled and non-skilled chimpanzee tool-users with voxel-based morphometry (VBM) to assess the link between tool-use and the IPL. The sample consisted of nine skilled and nine non-skilled female chimpanzee tool-users to avoid a possible sex bias. Tool-use skill was based on Z-scores for average performance time on a simulated termite-fishing task; Z-scores greater than or equal to 0.5 standard deviations above and below the mean were classified as non-skilled and skilled, respectively. A whole-brain VBM analysis indicated a trend toward bilateral gray matter differences in the IPL of skilled and non-skilled tool-users, with no significant differences in any other brain region. A VBM analysis focused on the IPL showed significantly increased gray matter in skilled chimpanzee tool-users compared to non-skilled tool-users in the left supramarginal gyrus (SMG; X=43, Y=75, Z=79; p=0.05). The left SMG is part of a left-lateralized network involved in human tool-use, and its anterior portion is activated during tool-use in humans but not macaques. SMG activation is also observed during expert stone tool-making in humans. Cortical variation associated with human-like tool-use and tool-making may have thus been present in the *Pan-Homo* last common ancestor, and could have provided a basis for the evolution of stone tool-making in the hominin clade.

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#### Weaning trajectories with nitrogen and hydrogen isotope ratios in calcified tissues

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Nitrogen isotope ratios ( $\delta^{15}\text{N}$ ) of tissues are frequently used in determining weaning trajectories in humans and primates. However, the method suffers from poorly-met assumptions, particularly in applications in the fossil record. Confounding factors include variability in isotopic offsets over time and between individuals and other biological effects on tissue  $\delta^{15}\text{N}$ , such as growth.

Teeth from experimental pigs show that hydrogen isotope ratios ( $\delta\text{D}$ ) track weaning trajectories more reliably than  $\delta^{15}\text{N}$ , and may not require the same assumptions as the latter method. We extend the stable isotope corpus of  $\delta\text{D}$  in teeth with M1 and M2 roots of humans and chimpanzees, and assess this method in contrast to  $\delta^{15}\text{N}$ .

#### An Unusual Interment of Dismembered Legs and Hands: A Roman Umbria burial puzzle

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This contribution presents the analysis of an unusual 4th – 5th ct. AD interment discovered at the *Vicus ad Martis Tudertium* on the western branch of the Via Flaminia in Umbria, Italy. The remains consist of fragmentary os coxae, both lower limbs and feet, and both hands. Skeletal articulation demonstrates that the appendages were fleshed upon interment, with the hands placed above the hips. There is extensive perimortem twig peel damage to the medial aspects of the os coxae as if the thorax and sacrum were forcibly separated from the legs at the sacroiliac joint. There is no evidence of cutmarks, nor are there any indications to the location of the upper body. The burial was in a simple, low status sealed *cappuccina* grave consisting of two ca. 58 cm tiles, with the legs occupying the majority of the grave. The grave cut paralleled the reduced size of the *cappuccina*, ruling out the possibility of post-depositional disturbance. Bioarchaeological analysis reveals this to be a prime aged male, ca 25-40 yrs of age, taller and more robust than the other individuals recovered from the site. The nature of the remains leads to the possible conclusions that the man suffered a violent injury that tore his body in half, possibly in the form of a military punishment, or there was post-mortem relocation of the body. The rural location and simple grave precludes the possibility of this being a gladiator death. Alternatively, this may represent a previously unknown form of *damnato memorei*.

#### What can footprint assemblages tell us about early hominin habitat preferences and social behavior?

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Footprint assemblages preserve unique records of events in specific locations over short periods of time. Interpreting their significance involves a number of challenges, including how to draw



statistically robust inferences about behavior based on a small number of individual sites. Recently, our excavations have unearthed hominin prints at several localities. To test the hypothesis that hominins are more abundantly represented among the footprint assemblages than expected based on their scarcity in the skeletodental fossil record, we used a random sampling procedure to identify outcrop areas in the Ileret Tuff Complex (c.9m stratigraphic section between 1.51-1.53Ma) near Ileret, Kenya. We excavated 20 different footprint surfaces (1x1m each) containing identifiable animal prints, documented the taxa represented, and compared their relative abundances to expected frequencies based on systematic sampling of dental and skeletal fossils ("bone walks") from the same area and stratigraphic interval.

Results show that bovid/suid prints are most abundant, as expected based on skeletodental fossil data. Water bird prints are also well represented, despite being rare among skeletal fossils. Their presence provides compelling evidence, combined with geological data and prints of other animals such as hippopotamids, that these sites were in close proximity to substantial bodies of water. Hominin prints occur significantly more frequently than expected, providing the best to date evidence that they spent disproportionate amounts of time in these near-water habitats. The presence of multiple large hominin prints, putatively males, on the same short-lived footprint surfaces further suggests a social dynamic involving male-male tolerance and perhaps cooperation.

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#### **How does access to human food affect wild long-tailed macaques (*Macaca fascicularis*) in Singapore?**

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Long-tailed macaque (*Macaca fascicularis*) groups that receive regular provisioning differ from those with no access to human food – specifically, provisioned groups are larger and spend more time interfacing with humans. We compared groups with no access to human food with those that obtain human food on an irregular basis (e.g., from improperly secured trash bins).

Our goal was to evaluate whether irregular access to human food is associated with differences in group structure and behavior. We collected scan samples on 67 long-tailed macaque groups in Singapore. Groups observed accessing human food were larger than those observed eating natural foods only. Subsequent comparisons statistically control for group size using multi-level modeling. Individuals in groups observed accessing human food spent more time in view of humans and utilizing manmade structures. They also spent more time traveling or in trees. Access to human food was unrelated to time spent using terrestrial substrates, eating natural food, or socializing. Our results suggest either that access to human food increased group size, or that larger groups out-competed smaller groups for access to human food. Either way, even irregular access to human food was associated with alterations in activity budgets, substrate use, and human-macaque exposure. Further research should clarify causal relationships among human-food access, macaque behavior, and other variables (e.g., humans and macaques preferentially residing in areas with resource-abundant flora). Such research could clarify whether management strategies that reduce human-food access would prevent disruption of long-tailed macaque group structure and behavior.

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#### **Analysis of visual cortical thickness, ocular volume, orbital volume and visual acuity in humans**

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The relationship among orbital, ocular, and visual cortical volume has recently been the subject of much anthropological research, and has generated numerous debates regarding the influence of the eye and orbit on the visual cortex. The principle objective of this study was to determine to what extent orbital and ocular volume is correlated with cortical thickness of the visual cortex (V1, V2, and V3), which has not been widely investigated.

MRIs of 155 individuals were used to evaluate cortical thickness of V1-V3 of the visual cortex. BrainSuite 13a was used to generate whole-brain segmentations with embedded cortical thickness values, and the Open Dx software package was used to sample 24 paired points along the calcarine fissure on the left and right hemispheres of the occipital lobe. Regression analysis was used to test the relationship between visual cortical thickness and orbital and ocular volume, visual acuity, and demographic variables. Results indicate that visual cortical thickness is not correlated with any of the above variables, and with regard to the primary research question specifically, orbital and ocular

volume were not found to be related to cortical thickness of V1, V2, or V3. This is an important result in the context of the current academic discussion regarding the relationship among the eye, orbit, and visual cortex in humans.

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#### **The biomechanics and functional anatomy of stone tool production**

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Recent archaeological finds show that stone tools predate *Homo* by more than half a million years. However, early lithic assemblages are rare and often have low numbers of tools and flakes. Only after the appearance of *Homo* are increases in site and artifact density evident. While these archaeological data indirectly support the hypothesis that efficient tool production and use are linked to adaptive changes seen in the genus *Homo*, these links remain tenuous. Understanding the functional consequences of shifts in hominin forelimb anatomy on knapping performance may provide a means of evaluating this hypothesis.

This study tests a biomechanical model of how power is generated during knapping. Kinematic data were collected from ten experienced knappers making simple Oldowan flakes from fine-grained basalt. These knappers were also fitted with motion-limiting braces on their shoulder and wrist to mimic aspects of the ancestral condition. Inverse dynamics analyses were performed to calculate angular velocities, torques and power at each major joint in the forelimb. Results show that modern knappers generate power using either an elbow or a shoulder-dominated strategy. While both produced usable flakes, the elbow-dominated strategy was more efficient, requiring fewer strikes per flake and less mechanical work. These efficiency data suggest that elbow-dominated knapping mechanics may have been favored by our tool-making ancestors. Further, we suggest that knapping behavior does not explain the anatomical shifts in humeral torsion and shoulder orientation between *Australopithecus* and *Homo*, but may have influenced selection for increased wrist hyperextension.

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#### **Differentiation of vocal repertoires in sympatric tamarins, *Saguinus imperator* and *Saguinus fuscicollis***

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Research on interspecific communication among sympatric primates has generally focused on alarm calls and predator avoidance. While the fitness advantage of interspecific alarm call response is evident, the degree to which species' full repertoire of calls is mutually intelligible is not fully understood. In feeding contexts, for instance, interspecies intelligibility of calls may serve to increase foraging efficiency; conversely, this could increase foraging competition and negatively impact an individual's ability to accurately assess mating opportunities. The long-term goal of this research is to investigate what factors drive the evolution of differentiation in vocal repertoires in closely related, sympatric species. To assess the degree to which the calls of morphologically and behaviorally similar species differ, I conducted 28 hours of acoustic recording of sympatric emperor and saddleback tamarins (*Saguinus imperator* and *S. fuscicollis*) from June to July in southeastern Peru; I then analyzed their calls for bioacoustic parameters that have been shown to be biologically significant in other primate taxa. To date, the vocal repertoire of *Saguinus imperator* has not been catalogued. While the upper and lower limits of the frequencies of their repertoires are similar, emperor tamarins and saddleback tamarins each produce species-unique vocalizations. Preliminary analysis also suggests that alarm calls, though similar, can be differentiated spectrographically as well. This suggests that vocal repertoires in these species are learned rather than morphologically or ecologically constrained. The next step in this research is to assess behavioral responses to opposing species' calls within the context of polyspecific associations.

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#### **The impact of bioarchaeological study on understanding the evolution of cardiovascular disease**

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Cardiovascular diseases (CVD - heart/blood vessels) are the leading cause of death in the world today, and are associated with the 2<sup>nd</sup>

epidemiological transition, and especially increasing longevity. CVDs (e.g. atherosclerosis) are related to many factors, including hypertension, heritability, diabetes, obesity/fatty diets/inactivity and smoking, but their antiquity is relatively unknown. While atheromatous plaques have been identified in blood vessels of mummies, most bioarchaeologists study skeletons. As the hallmark signs of CVD primarily affect soft tissues finding evidence associated with skeletons is challenging. This poster introduces the symposium and considers the direct and indirect evidence for CVDs in archaeological human remains. Direct evidence includes atheromatous plaques in blood vessels, calcified structures associated with atherosclerosis with skeletons, and some historical evidence, and indirect evidence includes dental disease (e.g. calculus/periodontitis), aortic aneurysm (spine), paralysis and bone atrophy ("strokes"), DISH (diabetes/heart disease), and tertiary syphilis. The increased potential of aDNA analysis is also shown, including the identification of CVD related genes. This long term evolutionary perspective, using direct and indirect evidence of CVDs, is important and potentially contributes to their understanding today.

#### **Taxonomic identification of isolated mandibular molars in *Australopithecus afarensis*, *A. africanus*, and *Paranthropus robustus* using geometric morphometrics**

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Molar morphology is considered to reflect evolutionary relationships such that taxa should be distinguishable using dental traits. However, fossil specimens are often incompletely preserved and may not be as readily identifiable to taxon. An unresolved issue is whether adding more incomplete specimens with a concomitant reduction in the number of landmarks will increase classification accuracy. This study utilizes geometric morphometrics to examine whether mandibular molar specimens (n=81) of *Australopithecus afarensis*, *A. africanus*, *Paranthropus robustus*, *Pan troglodytes*, *P. paniscus*, and *Homo sapiens* cluster with others in their species and with closely related taxa, and whether taxa can be differentiated from one another. Three 3D occlusal landmark datasets were investigated with different numbers of individuals and landmarks in each. After Procrustes superimposition the aligned landmarks were analyzed using multivariate tools. In all three principal components analyses both *Pan* species are separated from hominins on PC 1 and PC 2 distinguishes *H. sapiens* from all other taxa. The third PC axis separates out *P. robustus*, but only for the dataset including the maximum number of landmarks. In general, greater accuracy was achieved with the highest

number of landmarks included, followed by the dataset including the greatest number of individuals with the fewest landmarks. The results suggest that 3D landmark data derived from occlusal surface morphology can be useful in predicting affinity in both extant taxa and extinct forms. *Paranthropus robustus* exhibits the most distinctive molars among the fossils examined and shows a pronounced degree of variation in PC scores, as does *A. afarensis*.

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#### **A comparative analysis of vertebral microstructure in Neanderthal and modern human infant spines**

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The microstructure of hominin bone has been shown to vary between individuals and species, but to date few studies have attempted to compare patterns of juvenile bone growth and development at this scale. The aim of this project is therefore to assess the pattern of microstructural change in vertebral cancellous bone during prenatal, neonatal and early infant modern human and Neanderthal development. In this project we analysed a series of vertebral columns aged between 6 months prenatal to 2.5yrs postnatal from a 19thC museum human skeletal collections (UK), and three partial Neanderthal vertebral columns aged as a neonate (La Ferrassie 4), 23 months postnatal (LF8) and 3yrs postnatal (LF6) from the Musée de l'Homme in Paris. The morphology of trabecular architecture was imaged using micro-CT, between 24-28  $\mu\text{m}^3$  voxel size. Gestation was characterised by increasing bone volume fraction, whilst infancy was defined by significant bone loss ( $\approx 2/3^{\text{rds}}$ ) and the appearance of a highly anisotropic trabecular structure with a predominantly inferior-superior direction. Childhood development progressed via selective thickening of some trabeculae and the loss of others, maintaining bone volume whilst creating a more anisotropic structure. Overall the pattern of vertebral development appeared to be one of gestational overproduction followed by infant 'sculpting' of bone tissue during the first year of life, and then refinement during early childhood. The microarchitecture of the Neanderthal specimens appears to present a pattern of change very similar to that of modern humans, except for a more gradual decrease in BV/TV in the early months of life.

### Female friendships in a 'non-female-bonded' platyrrhine, *Ateles geoffroyi*

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Following Wrangham's (1980) model of female bonding, spider monkeys are traditionally considered a 'non-female-bonded' species. Although subsequent theoretical models expanded the distinctions within female-philopatric species, those with female dispersal were typically considered a singular category. Here, I address variation in female social relationships in 'non-female-bonded species,' drawing on my behavioral and hormonal study of black-handed spider monkeys (*Ateles geoffroyi*) at El Zota Biological Field Station. Other studies on this species report weak, undifferentiated social relationships among females. While my results supported this pattern for the majority of relationships, a subset of dyads demonstrated strong bonds that can be considered friendships. Out of the dyads that associated, only 39% engaged in affiliative interactions. However, the dyads that engaged in affiliative behaviors (groom, huddle, play, embrace) had significantly higher association indices than those that did not ( $U=341.00$ ,  $p<0.0001$ ,  $N=79$ ). Additionally, females exhibited trends toward engaging in higher rates of affiliation when cortisol was high ( $Z=-1.693$ ,  $p=0.090$ ,  $N=8$ ) and after receiving aggression ( $Z=1.826$ ,  $p=0.058$ ,  $N=7$ ), suggesting that they relied on female bonds to cope with stress. Using social network analysis, I will further explore how bonded dyads differ from non-bonded females in association patterns. Drawing on findings from other 'non-female-bonded' species such as hamadryas baboons and chimpanzees, I argue that female bonding does occur in species with female dispersal. However, these bonds may be easily overlooked when comparing mean relationship strength to other dyads within the same species, or female-female dyads in cohesive groups.

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### Bone volume, skeletal weight and body mass in *Homo sapiens* and the Sima de los Huesos hominins

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Researchers have long appreciated the significant relationship between body size and an

organism's adaptive strategy and life history. Body mass estimation in fossil human species is therefore a crucial topic in paleoanthropology since it yields information about biologically and ecologically relevant characteristics. The exceptional state of preservation of several fossil hominin long bones from the Sima de los Huesos (SH) Middle Pleistocene site in the Sierra de Atapuerca makes it possible to calculate for the first time the relative bone quantity of two femora and three humeri of a fossil human species. We have relied on CT scans and 3D virtual reconstructions to calculate bone volume in complete long bones, an approach not possible in fragmentary or poorly preserved fossils. A sample of 62 complete bones of recent humans was also used for comparative purposes. The male SH femora and humeri have, relative to their size, between 15-20% greater bone volume than the equivalent bones in recent humans. We have calculated the weight of the femora and humeri in both the SH hominins and our recent *H. sapiens* sample using the value for bone tissue density (1.8 g/cm<sup>3</sup>) which characterizes the Class Mammalia. Relying on regression formulae relating femoral weight with skeletal weight, the skeletal weight in two SH male individuals is estimated to be on average almost 60% heavier than the male individuals in our recent human samples. This in turn, influences their body mass and our estimates of this, and many other biological parameters in fossil humans.

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### An assessment of degenerative joint disease of the hip and shoulder in a Cypriot community from Limassol, Cyprus

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Degenerative joint disease (DJD) is one of the most common pathological conditions observed in skeletal collections. DJD is the destruction of articular cartilage and bone at the joint surface. It can be associated with advanced age, work habits, mechanical stress or the result of injury to the limbs. Evidence of DJD is visible through a series of lesions including porosity, lipping, osteophytes, eburnation, and, in rare but severe cases, ankylosis of the joint. This research focuses on degenerative joint disease of the hip and shoulder among remains exhumed from the St. Nicholas Cemetery in Limassol, Cyprus. This sample of burials was examined during the 2014 study abroad field school sponsored by Texas Tech University. The sample is unique in that we are provided with known demographic information regarding age and sex. The purpose of this project is to assess the frequency of

degenerative joint disease specific to the hip and shoulder joints in Cypriot individuals from this community. Thirty geriatric skeletal remains are analyzed for the common lesions associated with DJD. Each joint is treated as an individual unit. Lesions were scored to type (eburnation, osteophytes, and porosity) and to the degree of severity. Since the sample is small, analysis of data is completed using the Fisher's exact test. We find that degenerative joint disease of the hip and shoulder is not sex specific for this sample and that old age is a critical factor in the presence of severe lesions.

### CYP19A1 methylation: life history factors' effects on the genome

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Epigenetic research enables the identification of processes connecting environmental and genetic factors. However, few studies have investigated the relationship between human life history traits and methylation, an epigenetic process that is both heritable and modifiable. CYP19A1 is a gene critical for the estrogen biosynthesis pathway, and methylation patterns have previously been associated with age of menarche in an urban female population. In this study, we hypothesized that methylation of CpG sites in the CYP19A1 promoter would be associated with life history traits including age of menarche, number of children, and breastfeeding duration. The study included 53 rural, agricultural Polish women between the ages of 18 and 45 recruited at the Mogielica Human Ecology Study Site. The average age of menarche was 13.4 years (SD 1.67 years). In the sample population, 43.4% of the women did not have children. Among women with children (n=30), 36.7% had 1 child, 26.7% had 2 children, 23.3% had 3 children, 6.7% had 4 children, and 6.7% had 5 children. The women with children breastfed for 0 to 24 months with an average of 8.81 months (SD 6.26 months). This data suggests that there is sufficient variation in this population to test the hypothesized association of life history traits and CYP19A1 promoter methylation. Future project directions include researching methylation of additional genes to gain a better understanding of the relationship between environmental and genetic factors. Through this study, we begin to unravel one of the mechanisms by which reproductive factors may modify gene expression.

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**Eastern Mediterranean Communications Zone in the Pleistocene: Paleoanthropological and archaeological evidence**

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A hominin mandible BH-1 from the Middle Pleistocene cave of Mala Balanica suggested a tantalizing possibility that human populations in this part of the Continent were not subject to the process of Neanderthalization observed in the west. Current consensus sees Neanderthals as descendants of European \***Homo heidelbergensis**\* who spread northwards and eastwards in a pulsing fashion dictated by retreating glaciers. With paleontological evidence supporting successive movements of fauna from Africa / Southwest Asia (SWA) into Europe in the Early and Middle Pleistocene, this has served to strengthen the demographic “sinks and sources” model that postulates a demographic source population in SWA region. The Balkans, lacking any geographic barriers to SWA, represents a logical continuation of this region. Building on the scant – but growing – fossil human record contextualized by more abundant archaeological data, we examine the evidence for this larger Eastern Mediterranean Communications Zone in the Middle and Upper Pleistocene record.

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**The Boars of Summer: Estimating Time-Since-Burial in Southwest Florida**

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Time-since-death and time-since-burial (TSB) estimation methods have grown from research conducted within the University of Tennessee. Through decades of analyzing buried remains, Dr. Arpad Vass established two Postmortem Interval (PMI) equations. Of interest to this study was Vass' TSB equation. Key equation variables included soil moisture, soil temperature, and skeletonization percentage. Soil moisture differs markedly between Knoxville (40-80%) and Fort Myers (15-40%). Furthermore, because previous research has found warm temperatures increase the rate of decomposition (Van't Hoff's Law) and an increase in soil moisture slows body

decay rate, we anticipated the equation would overestimate the TSB.

As part of a student research opportunity for middle school students conducted with the Whitaker Center for STEM Education and the FGCU Human Identification and Trauma Analysis graduate students and faculty, we collected data to test the TSB equation using pig (*Sus scrofa*) cadavers. We also collected soil temperature and moisture readings at the burial surface (0-3cm) and within the grave using Vernier probes. The percentage of skeletonization was estimated when the remains were exposed *in situ*.

Our data revealed that Vass' buried body equation overestimated TSB with no consistent degree of overestimation (64, 255 and 704 days longer than the true internment period). Statistical analysis revealed that despite the differences in TSB, this timeframe was insignificant. Further research is necessary to properly adapt Vass' postmortem interval equation for Southwest Florida. Moreover, exogenous variables such as insect activity, perimortem trauma location, and soil pH inevitably affected the overall rate of decomposition.

**Developmental shifts in rhesus macaque gaze following**

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Gaze following, or co-orienting with others, is a critical social-cognitive capacity allowing individuals to acquire information about their social or physical environment. While this is a foundational social skill in human ontogeny, little is known about its emergence in other species. We examined gaze following in semi-free-ranging rhesus macaques (*Macaca mulatta*) living on the island of Cayo Santiago. We tested a large sample (n=406 monkeys; 214 females; 0.5 to 28 years old) using an experimental method in which an experimenter attracted a monkey's attention and then gazed upwards. We found that gaze following increased in the second year of life but then declined: older monkeys looked up less often than younger monkeys. Importantly, co-orienting behaviors can stem from reflexive responses to other's gaze, or from more complex reasoning about what others are seeing. We therefore examined patterns of looking to assess the psychological processes underlying the monkeys' behavior. Our first index was whether monkeys made multiple independent looks, indicating that the individual was trying to judge the (absent) target of gaze. We found that infants and juveniles produced more discrete looks than adults. Our second index was whether monkeys habituated to the experimenter's gaze over trials, indicating that monkeys flexibly inhibited their responses in

the absence of a clear target. We found that infants exhibited such habituation, but juveniles and adults did not. These results indicate that monkeys show robust ontogenetic shifts in gaze following, which has implications for understanding evolutionary changes in cognitive development across species.

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**A synthesis of genotype and phenotype reveals the multi-causal nature and complexity of human cranial evolution**

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The comparative study of human phenotypic variation among recent and living groups is crucial for evaluating hypotheses of human adaptation. Comparative methods make a series of assumptions about the distribution of genetic similarities among groups and the forces of evolution. Using a combination cranial and whole-genome molecular data in conjunction with a maximum likelihood general hierarchical modeling framework, we compare the goodness of fit of evolutionary models assumed in most comparative studies of human variation. We also investigate models that allow for tests of a variety of hypotheses of the causes of phenotypic evolution against a background informed by genomic variation. Our results show that models of evolution assumed by many comparative studies of human phenotypic variation are poor fits to both phenotypic and genomic data. The goodness of fit of more complex models shows that a combination of random genetic drift and neutral mutation on one hand, and natural selection on the other, is responsible for the evolution of recent human cranial diversity. The effects of environment and gene flow may also be substantial. We show that none of these conclusions could be arrived at using either phenotypic or genomic data alone. The former is too noisy to be of use in reconstructing population history and the latter contains almost no information about the action of natural selection on most phenotypic traits. Washburn's (1951) call for a synthesis of the study of phenotype and genotype is as timely as ever.

*Early parts of this work were completed during a fellowship semester funded by the Center for Advanced Study, University of Illinois, Urbana-Champaign.*

**The effects of paternity and male rank on male-immature relationships in the mountain gorilla (*Gorilla beringei beringei*)**

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Kin discrimination mechanisms are expected to evolve when they provide fitness benefits. In species with promiscuous mating systems, males were long believed to abstain from parenting behaviors partly because the costs of potential offspring misidentification outweighed the benefits of dual parenting. Recent work has shown that in some species males parent despite high rates of false paternity, and males in some promiscuous systems discriminate between their own and other males' offspring. Adult male mountain gorillas (*Gorilla beringei*) and immatures in their groups have close relationships even when paternity certainty is low, and such relationships are best explained as low-cost parenting behavior. Using an information theoretic approach, we evaluated the impact of rank and paternity on male/immature relationships in wild multi-male gorilla groups monitored by the Dian Fossey Gorilla Fund's Karisoke Research Center. In our sample of 21 adult males and 50 genotyped immatures, males and 1-5 year old immatures clearly use rank, not paternity, to choose preferred social partners. Males and immatures were closer social partners in 2011-12 when reproductive skew was low and group size smaller than in 2003-04 when skew was high and group size larger. Gorillas' lack of paternal kin discrimination provides further behavioral evidence that the species' multi-male social structure is evolutionarily novel. However, patterning of male-immature relationships and genetic paternity suggest a persistent minority of bi-male groups throughout *Gorilla beringei's* evolutionary history. This may help explain their ability to live for extended periods in multi-male, multi-female social units despite possessing morphological characteristics typical of harem systems.

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**Are human infants altricial?**

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Human babies are born in an unusually helpless condition that Portmann called "secondary altriciality." Ashley Montagu characterized them as "extero-gestate fetuses". These scholars and others have emphasized the helplessness of our newborns and the resulting needs that they have for intensive care by parents and alloparents. In many ways, however, human infants are completely unlike the infants of other animals who are also born helpless. The terms *precocial* and *altricial* describe a continuum of developmental states in birds and mammals, but it is difficult to place humans on this continuum. Humans have relatively long gestation lengths similar to the precocial great apes (e.g., averaging 268 days for *Homo*, 232 days for *Pan*, 257 days for *Gorilla*), but our babies are relatively larger than theirs (6.1% of maternal weight compared to about 3% in African apes) with relatively small brains (29% of adult brain size compared to 40-45% in African apes). This combination of large bodies, small relative brain size, and extreme motor immaturity makes human infants costly creatures to carry around and to parent. The use of the term "secondarily altricial" to describe their helpless condition fails to capture the unusual nature of the human newborn developmental status and the opportunities for learning that our infants may experience in their early entrance into the cultural and social world. The human pattern accommodates the obstetrical, locomotor and energetic constraints imposed by encephalization, with the recognition of a headstart in infant learning afforded by birth of an immature infant.

**Body Mass in Forensic Anthropology: Can it be Estimated?**

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Forensic Anthropologists can estimate a decedent's sex, ancestry, age and stature with a relatively high degree of accuracy. However, in the case of an unidentified decedent the aforementioned biological profile may not be enough information to ascertain their identity. Being able to estimate body mass would allow for additional biological parameters to be used that may assist in the identification of unknown individuals. The aim of this study was to explore if standard measurements taken from the femur can be used to estimate body mass. The sample for this study totaled 159 known individuals (of known age, sex, stature, weight, etc.) from the University of Tennessee forensic database. Males (n=95) and females (n=64) were analyzed separately, which included individuals of all ancestries. Body mass index was calculated according to the Centers for Disease Control equation. Cross-sectional external measures using standard measurements were used to calculate an elliptical model of total subperiosteal area (TA) for subtrochanteric and

midshaft AP and ML measures. TA was calculated as:

$$TA = (AP/2)*(ML/2)$$

Subtrochanteric shape and midshaft shape ratios were also calculated. The ANOVA results show that there was significant BMI effect on the midshaft ratio, total subtrochanteric periosteal area and total midshaft periosteal area in males ( $F = 4.67$ , p-value 0.03;  $F = 5.13$ , p-value =0.03;  $F = 4.79$ , p-value 0.03, respectively). ANOVA results for females only showed a significant BMI effect for total subperiosteal area ( $F = 3.84$ , p-value = 0.05).

**Functional significance of the location of the axis of rotation of the mandible**

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The location of the finite helical axis of the mandible (HA) was quantified in seven individuals from three species of primates (*Papio*, *Cebus*, *Macaca*). These data were used to test two hypotheses regarding the functional significance of anteroposterior mandibular condylar translation and the location of the HA during feeding: 1) condylar translation is necessary to facilitate mandibular depression without impinging on crucial cervical structures; and 2) the mandibular axis of rotation is located near the lingula of the mandible during jaw opening to prevent stretching of the inferior alveolar neurovascular bundle (IANB). The locations of the HA at maximum angular velocity during jaw opening and closing displayed species-specific patterns. The HA is located near the occlusal plane in *Papio* and *Cebus*, but closer to the condyle in *Macaca*. The HA is located anteroinferior to the condyle in *Papio*, and inferior/posteroinferior to the condyle in *Macaca* and *Cebus*. The impingement hypothesis predicts that species with larger gonial angles like *Cebus* have more inferiorly located HAs than species with more obtuse mandibular angles like *Papio*. Low HAs in *Papio* compared to *Cebus* and *Macaca* do not support this hypothesis. The HA seldom passes near or through the lingula, falsifying the hypothesis that its location is determined by the sphenomandibular ligament, and suggesting that it does not function to protect the IANB from stretching. Condylar translation is widespread in primates. Its presence in humans is most parsimoniously interpreted as a primitive retention and not as an adaptation to speech or upright posture.

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**Legions of lesions: An examination of the severity and prevalence of dental caries in medieval Bögöz**

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Previous studies have shown that adults have higher frequencies of caries than subadults. However, the distribution of where these are located has not been systematically presented by tooth type, nor have the two arcades been compared for average caries severity. In this study, we recorded the presence, location and severity in two groups of individuals – Subadults (n = 16) and Adults (n = 24) – from a medieval Transylvanian population from the site of Bögöz (Mugeni). Based on previous studies we hypothesized that the distribution of caries among tooth types in both populations would follow a pattern and that the molars would have the highest incidence of carious lesions. Our results agree with previous studies in that the Adults had a greater proportion of individuals with carious dentition, as well as a higher average number of carious teeth per individual. While both groups supported our hypothesis, Subadults had a higher frequency of approximal caries whereas Adults had a higher frequency of caries on the occlusal surface. Also, unlike in the Subadults, severity was asymmetrical in the Adults – significantly higher in carious teeth of the lower arcade than the upper.

These findings are consistent with historical data on medieval agriculture and diet within the region that produced cariogenic einkorn wheat, rye, barley, and oats – all made even more cariogenic when processed into traditional white bread. Thus one can infer that this cariogenic diet combined with insufficient dental hygiene contributed to the prevalence of dental caries in this population.

**Cannabis vs helminth infection: Cannabis use as chemoprophylaxis against intestinal helminth infection among Aka forest-foragers of the Central African Republic**

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Vertebrate-helminth (parasitic worms) coevolution has had profound implications for

human health. It is possible that behavioral anti-parasite strategies, i.e. non-immunological defenses, were also shaped by vertebrate-helminth coevolution. Whereas plants produce a number of toxins to deter predation, herbivores have co-evolved to use plant toxins to defend against their own parasites. In a previous study we explored the hypotheses that recreational drugs (i.e. tobacco) are consumed to treat and/or prevent parasitic infection (“human pharmacophagy”). We found support for the pharmacophagy hypothesis using a randomized control trial and a one-year follow-up reinfection study among Aka forest-foragers of the Central African Republic. Here we report new data on the relationship between cannabis use and helminth reinfection in this same population. In one of the first biomarker-based study of psychoactive drug use among hunter-gatherers we found that cannabis use was widespread among adult men. Significant negative correlations were observed between urinary THC and helminth reinfection scores. Results support the pharmacophagy chemoprophylaxis hypothesis, and provide novel insights into the relationship between drug use and helminth infection, two of the world’s great health problems.

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**Health disparities in prostate cancer: Tumor epigenome profiling in African American vs European American men**

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Worldwide, men of African ancestry have the highest incidence of prostate cancer and they are more than twice as likely to die from the disease as other populations. Multiple factors may contribute to these disparities including socioeconomic, education, diet, access to healthcare, type of treatment, and biological factors such as genetics and epigenetics. Here we characterized DNA methylation profiles for African American compared to European American prostate cancer patients. The Infinium HumanMethylation450 BeadChip array (Illumina) was used to determine methylation status for ~480,000 CpG sites in prostate tumor tissues from 44 African American and 479 European American men who underwent radical

prostatectomy as primary treatment and were enrolled in population-based studies. Preliminary results based on comparisons of M-values (Minfi, Bioconductor) showed that 493 CpGs had significant differences in methylation levels between the two groups at  $p \leq 1.04 \times 10^{-7}$  (adjusted for multiple testing), with 55% of these CpG sites being hyper-methylated in African Americans vs. European Americans. Subsequent analyses examined methylation patterns within African Americans stratified by Gleason score, pathological stage, recurrence status, or a composite measure of these disease features. CpGs with significant differences in methylation levels for Gleason score (1 CpG) and recurrence status (2 CpGs) were identified. Of the recurrence-associated CpGs, one is located in the transcription start site of anti-tumorigenic gene *ADAMTS12* and the other is in the gene body of *LASPI* (previously associated with breast and colorectal cancers). Further analyses may identify differentially methylated sites that contribute to tumor aggressiveness in African American men.

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**Minimal VO<sub>2</sub> of Women Walking Burdened on Gradients in Urban Environments**

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Oxygen consumption (VO<sub>2</sub>) increases rapidly with increasing velocity, burden, and incline but the relationship of VO<sub>2</sub> with decline is more complex. For unburdened conditions and while walking at normal velocities, VO<sub>2</sub> is lower on a shallow decline than it is on a flat surface, but at approximately -10% VO<sub>2</sub> is believed to reach a minimum. Beyond -10%, steeper declines induce higher VO<sub>2</sub>. Whether or not this relationship is similar for burdened conditions remains unknown.

In order to understand at which gradient the minimal energy expenditure of walking occurs in burdened and unburdened conditions, we assessed the VO<sub>2</sub> of ten females (ages: 22-40) with a portable Cosmed K4b<sup>2</sup> device. Participants walked at three self-selected velocities (slow, normal, and fast) on five gradients in an urban community setting (0%, +/- 7.5%, +/- 12.4%) burdened (10 kg) and unburdened. All trials were randomized. We performed a linear regression controlling for repeated measures to determine the best predictive equation for VO<sub>2</sub>. The first derivative of our equation was used to find the minimal VO<sub>2</sub>.

With the covariates velocity, burden, gradient, and gradient squared included (all  $p < 0.001$ ), our



equation explains 77% of the variation in  $VO_2$  ( $r^2=0.77$ ). Our minimal  $VO_2$  occurs at approximately -14%, a steeper slope than previous work found. This suggests that walking outside on naturally occurring hills may be different than walking on a treadmill in a laboratory. In order to explore this further, more research on walking outside the laboratory should occur.

#### **The effects of hip joint loading on body mass estimation in early hominins**

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Structural analyses of the femoral neck and diaphysis suggest that hip joint reaction force was reduced relative to body mass in australopiths compared to modern humans and early *Homo*. If true, this implies that body mass estimates derived from femoral head size in modern human reference samples may be too large in australopiths. Consistent with this hypothesis, knee joint breadth gives higher body mass estimates than femoral head breadth in australopith samples, including AL 288-1, but not early *Homo* samples. Body mass estimated from femoral head size in the Gona pelvis also appears low relative to its bi-iliac breadth, and results in a very short stature estimated from reverse regressions of stature on body mass and bi-iliac breadth in modern humans. Consideration of all of these factors suggests that a correction factor on the order of a 20% increase may be necessary when using femoral head size to estimate body mass in australopiths. Application of this correction to available fossil hominin specimens results in slightly different temporal trends in body mass, with more continuity between australopiths and early *Homo*, although there is still a significant increase in body mass in *Homo*, particularly after 1.5 Ma.

#### **Comparison of limb bone diaphyseal cross-sectional properties in tree shrews, tree squirrels, and dwarf and mouse lemurs**

JACQUELINE A. RUNESTAD CONNOR, Department of Biological Sciences, Ohio Northern University.

This project's initial hypothesis was that generalized small mammals inhabiting forested environments will be similar in function-related limb bone traits. The sample includes Tupaiidae, Sciuiridae, and Cheirogaleidae. Emmons (2000) describes tree shrews as well-suited for running, jumping, and climbing, much like tree squirrels and mouse and dwarf lemurs.

Limb bone properties analyzed include humeral and femoral lengths, and midshaft cross-sectional properties obtained from X-rays. Species

averages for these properties were calculated and regressed on body mass and each other. ANCOVA was used to compare elevations and slopes of these regressions among the three mammal groups.

Results show that both tree shrews and tree squirrels have greater humeral cross-sectional cortical area than do cheirogaleids. Tree squirrel humeral diaphyses are more oval in cross-section, with an anteroposterior long axis, compared to the other two groups which have rounder cross-sections. Cheirogaleids have longer femora than the other groups do.

These structural differences probably correspond to behavioral differences, although they may also result from evolutionary constraints. Tree shrews and cheirogaleids seldom climb large vertical tree trunks like squirrels do. Thus, deltoid musculature may be more developed in squirrels, causing anteroposterior expansion of the shaft even distal to the deltoid tuberosity. Cheirogaleids' greater femoral length suggests they are better at leaping than the others. However, tree squirrels also make impressive jumps.

#### **Bundle Number, Body Mass, and Bipedality: Probing the Comparative Anatomy of the Anterior Cruciate Ligament**

AIDAN A. RUTH, MARY ANN RAGHANTI and C. OWEN LOVEJOY, Anthropology, Kent State University.

Failure of the anterior cruciate ligament (ACL) is the most common knee injury in humans. This research is an attempt to establish fundamental parameters of structure in the human ACL compared to those of other primates. To address this aim we examined the gross anatomy and histology of the knee in primates (11 species) in order to quantify the number and anatomy of ACL bundles as well as their tibial insertions using computer-assisted stereology.

The ACL bundle number visible during gross anatomical dissection is conserved in primates, including humans (2 bundles). Fibrocartilage thickness at the tibial insertion appears to be absolutely conserved across all taxa when tested with one-way ANOVA ( $F=1.580$ ,  $P=.179$ ). Ratios of ligament midsubstance circumference to its tibial insertion area scaled almost perfectly with body size across all taxa examined ( $r=.990$ ,  $p<.001$ ). This study is the first to examine ACL bundle number in non-human primates and other mammals, and the first comparative examination of ACL insertion microanatomy. These data suggest that evolution of the ACL, in terms of bundle number and fibrocartilage thickness, has been extremely conserved in primates, and that adaptations for locomotion lie in other aspects of the ACL and knee.

#### **Placentergetics: exploring placental investment in fetal somatic and brain development**

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The placenta is responsible for delivering glucose and other nutrients from maternal circulation to the fetus, with particularly implications for the development of the primate brain. A series of 50 vervet monkey (*Chlorocebus sabaeus*) placentas from the St. Kitts Biomedical Research Foundation was characterized in terms of microscopic morphology and shifts in efficiency across the latter half of a species-typical 167-day gestation, divided into period 1 (d. 83-130) and period 2 (d. 131-159). Architecture was analyzed via stereology. Both fetal and placental mass increased significantly with gestational age (Pearson's correlations:  $R=0.85$ ,  $P<0.00001$ ;  $R=0.64$ ,  $P<0.00001$ , respectively) though relative placental mass decreased. However, the surface area of the placental villi – the site of nutrient transport from mother to fetus – increased significantly between the two time periods, both in terms of volume (T-test:  $T=-4.49$ ,  $P<0.00001$ ) and surface area (T-test:  $T=-5.33$ ,  $P<0.00001$ ). These changes suggest there is an important shift in the metabolic capacity of the placenta, via an expansion of the microscopic surface area of the villi to support the energetic burden of late gestation brain and somatic growth. Preliminary data regarding analyses of placental glucose receptor 1 (GLUT1) production, as well as magnetic resonance imaging of the fetal brains themselves to track the development of cerebral cortex and the corpus callosum relative to placental characteristics across gestation will also be discussed. A better understanding of how the placenta drives and constrains fetal and brain growth in anthropoid primates is directly relevant to developmental models of the metabolic processes underlying human brain evolution.

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#### **Ontogenetic development of trabecular bone in the human postcranial skeleton**

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The onset and continued maturation of bipedal walking in humans is associated with significant increases in body mass and mechanical loading of the postcranial skeleton. This study investigates the role of these locomotor and mechanical changes on the developing trabecular bone structure in a suite of five long bone metaphyseal locations. We predict that the ontogenetic patterns of trabecular bone structure will reflect general developmental processes influenced by site-specific joint kinematics and kinetics. Three-dimensional trabecular bone architecture in the proximal humerus, proximal and distal femur, and proximal and distal tibia was quantified from microCT data in 71 individuals from the Norris Farms #36 archaeological skeletal collection. Individuals ranged in age from neonate to adult. Results indicate that metaphyseal trabecular bone follows very similar patterns of development in most of these long bone sites. Bone volume fraction (BV/TV) is highly variable within and between individuals, remaining relatively constant throughout ontogeny. Connectivity density (Conn.D) decreases significantly with increasing age, while both trabecular thickness (Tb.Th) and spacing (Tb.Sp) both increase significantly until adulthood. The degree of anisotropy displays the highest variation between sites, possibly reflecting local functional adaptation to joint-specific loading. The proximal femur stands out in having significantly higher BV/TV with thicker and less widely-spaced trabeculae than most other regions analyzed. Although some regional differentiation is apparent, the broad similarities in trabecular bone developmental trajectories may reflect a generalized, genetically-influenced patterning independent of external mechanical stimuli.

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#### Within and beyond Africa: Genetic ancestry of Jamaican Maroons

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The Accompong Maroons of Jamaica are a community with distinct cultural traits and a unique history. Contemporary Maroons descend from enslaved Africans who, in resistance to British colonial rule, formed semi-autonomous communities within Jamaica's hinterland beginning in the 17<sup>th</sup> century. Scholars have debated the origins of the founding members of the Accompong Maroon community, with some scholars claiming African and Native American ancestry while other scholars only noting African ancestry. While cultural and archaeological information provide some evidence regarding

Maroon origins, genetic data offers an alternative perspective on the question of Maroon ancestry.

In this study we consider the genetic ancestry of 50 Accompong Maroons in order to elucidate their African and possibly Native American biogeographical origins. In previous studies we genotyped haplogroup defining markers from two genetic systems: mitochondrial DNA and Y-chromosome loci. In the current study, we estimated individual admixture using 13 autosomal loci (CODIS microsatellites) in order to gain a fuller understanding of Accompong Maroon ancestry. Based on mitochondrial DNA, 96% of the Accompong Maroons have African maternal ancestry with the remaining 4% tracing to the Americas. Analyses of the Y-chromosome loci indicate that 68% have African paternal ancestry while the remaining 32% have European paternal ancestry. Average individual admixture estimates from the autosomal markers are 76% African, 18% Eurasian, and 6% Asian ancestry. Taken together, the data from the three genetic systems suggests that the genetic history of Accompong Maroons is both reflective of its colonial past and congruent to community oral history.

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#### Geological and taphonomic aspects of the Sima de los Huesos site

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The Sima de los Huesos (SH) is one of the many archaeo-palaeontological sites in the Sierra de Atapuerca, but their characteristics are unusual, due to the large size of the hominin accumulation and its location. It is well-known for yielding an enormous collection of Middle Pleistocene hominin fossils – the most ever found at a single site. The hominin fossils occur among carnivore fossils (mainly *Ursus deningeri*) with an isolated Acheulian handaxe (and without a single herbivore remain). In order to investigate the site formation we have performed a study of the stratigraphical sequence, depositional history of SH and taphonomic analysis. The results show that: i) there was only one stratigraphic event of hominin accumulation; ii) the bones are included in pure muddy silt, infiltrated by drops and decanted in a low energy sedimentary environment. The fossils were not transported to SH from a locus of primary accumulation remote from their present day location; iii) Cave bears and other carnivores occur with the hominin fossils in the same layer, but carnivores

continued accumulating above the hominin deposit in an overlying layer; iv) at the time of the hominin and carnivore fossil accumulations, the only possible access to the SH chamber was a deep vertical conduit, which was impossible to climb; v) the carnivores were not responsible for the hominin accumulation. Other possible origins of the accumulation of hominins in SH must be explored, but we can rule out carnivores and geological events as taphonomical agents.

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#### The effect of caller activity, proximity and habitat visibility on calling rates of grunts in western gorillas (*Gorilla gorilla*)

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In primate groups, close calls commonly function either 1) to reduce the likelihood of individuals becoming separated, or 2) to reduce conflict by facilitating social interaction or by regulating spacing between potential foraging competitors. Most studies however have focused on monkey species, and less is known on how apes modify the frequency of their calls during different conditions. Here we test whether activity, proximity and habitat visibility have an effect on the occurrence of two commonly western gorilla calls, double and single grunts. Behavioral data (504 follows) were collected over a 13-month period from one silverback male and four adult females at the Mondika Research Center, Republic of Congo. Our results show that double grunts were more frequent during resting and when the closest individual was < 10m whereas single grunts were more so during foraging, when the closest individual was < 10m and visibility was low. There was however a significant effect of activity on proximity and habitat visibility, with calling being more frequent during travel when the closest individual was further apart or habitat visibility reduced. Our findings suggest therefore that western gorillas use close calls more generally to reduce conflict by both facilitating social interaction (double grunt) and spacing potential foraging competitors (single grunt). Individuals however might occasionally use them when traveling also to reduce the likelihood of becoming separated (single grunt). The study suggests not only that close calls in western gorillas serve multiple functions but also that the two hypotheses are not mutually exclusive.

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## AAPA Abstracts

*Fund, Richard Leakey and Wildlife Direct, Stony Brook University.*

**Analysis of cell-specific regulatory DNA reveals elevated immune specificity in genomic regions of high Neandertal ancestry**

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Following King and Wilson, many studies have suggested the importance of regulatory evolution in driving adaptive divergence between species. This observation makes regulatory regions prime candidates for adaptive introgression between closely related populations. This is particularly true in the adaptive immune system, where genetic variation is essential to adaptive responses to pathogen diversity. Neandertals, a population of archaic humans that lived in Europe and Central Asia between ~200 and 30 thousand years ago make up at least 1.5% of the ancestry of modern humans with recent ancestry outside of sub-Saharan Africa. We tested the hypothesis that Neandertal introgression contributed disproportionately to the immune systems of modern humans. To that end, we analyzed regulatory specificity in a set of DNase I hypersensitive sites, a genomic approach to characterize regulatory DNA, from karyotype normal immune- and non-immune cells from the ENCODE project. We find that DHS with higher amounts of Neandertal ancestry in the 1000 genomes project are enriched with regulatory regions that are highly specific to active T-cells. We further characterize these results in the context of natural selection by utilizing information about the haplotype structure around T-cell specific regulatory sites, information content of Neandertal-derived alleles in binding motifs, and gene-expression data.

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**Cathemerality and sleep intensity in seven captive lemur species**

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Most primates spend about one-third of their lives asleep, yet we know remarkably little about the factors that drive this variability. Of particular importance in this regard is sleep intensity (SI), which is hypothesized to vary among primates and to be an important factor in human sleep. SI encompasses two variables that are behavioral proxies for slow wave sleep: *sleep fragmentation* (the number of brief awakenings

greater than 2 minutes per hour) and *sleep arousability* (number of motor activity bouts per hour). Here, we report on data generated from 99 individual lemurs representing seven species at the Duke Lemur Center. We test the hypothesis that sleep intensity will be lower in cathemeral compared to diurnal species. Using actigraphic collars (CamNtech, Motionwatch 8), we recorded a cumulative activity score over each minute for the duration of each subject's session (12 h blocks between 18:00-06:00; mean = 7 nights; total subject nights = 691). We found that lemurs are characterized by variable SI values, and that cathemerals exhibit greater arousability ( $n = 77$ , mean = 22.2, SD = 0.7 vs.  $n = 22$ , mean = 18.1, SD = 5.9,  $P = 0.009$ ) but not fragmentation ( $n = 77$ , mean = 2.7, SD = 0.6 vs.  $n = 22$ , mean = 3.01, SD = 1.1,  $P = 0.25$ ) when compared to diurnals. These data suggest that cathemeral lemurs may be the lightest sleepers of all the primates, yet their sleep architecture is likely similar to diurnal primates.

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**Longitudinal dynamics of urinary C-peptide during early peri-menopause in Toba women: A preliminary analysis**

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During the 4-5 years preceding menopause, women may experience significant changes in glucose metabolism associated with variation in ovarian hormonal levels. This preliminary study assesses the longitudinal dynamics of insulin levels (measured via urinary C-peptide) during early peri-menopause and its association with anthropometric measures and estrogen conjugates (E<sub>1</sub>C) levels. Urine samples were collected from healthy Toba women ( $n = 6$ ) living in northern Argentina. Each woman contributed an average of 83 urine samples collected 2-4 days apart, three times per year over a span of 2 years. All participants were still menstruating at the time of collection, had never used oral contraception, and were, on average,  $42.4 \pm 1.9$  years old. Overall, C-peptide levels were relatively similar among participants, and tended to be concentrated on lower values (mean  $113.0 \pm 110.9$  ng/mg Creat, median 68.0 ng/mg Creat). Linear regression analyses indicate variation across individuals in dynamics of C-peptide levels over time, as women either demonstrated decreasing or stable urinary levels. There was no significant association between average C-peptide levels and height or body mass index. However, E<sub>1</sub>C and C-peptide levels were positively correlated for 4 out of the six women. There were no seasonal differences in C-peptide levels (winter:  $115.4 \pm 110.4$  vs summer:  $116.5 \pm 127.5$  ng/mg Creat). Metabolic dynamics and their health effects across menopause are particularly relevant to Toba women because of emerging health concerns for this population related to their recent transition from foraging to

a diet characterized by high-calorie processed foods.

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**Paleoepidemiological approaches to treponemal disease**

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Debate over the origin and antiquity of syphilis and the other treponematoses has acted as one of the primary stimuli for research in paleopathology for over a century. Most scholarship on archaeological cases of treponemal disease, however, has been in the form of case studies; paleopathology has only been able to meaningfully address major questions about the evolution of disease by moving away from case studies towards population-based analyses. Therefore, here we orient away from this historical focus on case studies towards epidemiological analysis of aggregate skeletal samples over multiple regions and time periods. Reported cases of individuals manifesting evidence of treponemal disease ( $N \Rightarrow 17,986$ ) from the pre- and post-Columbian New and Old Worlds derived from gray and published literature were evaluated against established, standardized criteria for dating and the diagnosis of treponemal disease in order to generate novel insights into the natural history, ecology, manifestations, and evolution of treponemal disease. Preliminary results from analysis of a subset of the data suggests higher frequencies of skeletal involvement in treponemal disease than are suggested by estimates of skeletal involvement reported in clinical and epidemiological literature. We discuss the possible explanations for these findings, including the role of publication bias and sample sizes, as well as their potential implications for paleoepidemiological approaches to treponemal disease for paleopathological and bioarchaeological scholarship on the treponematoses.

**The effect of reproductive state on female-female associations in chimpanzees (*Pan troglodytes*) at Taï National Park, Côte d'Ivoire**

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Primateology, Max Planck for Evolutionary Anthropology.

Chimpanzee (*Pan troglodytes*) communities are characterized by a fission-fusion social structure where party size and composition are influenced by sex, reproductive state, age, rank, relatedness, and access to food. At Taï National Park, female chimpanzees are highly social and maintain preferred associations for years. However, female sociality and gregariousness are expected to vary according to reproductive state. Previous studies show that estrous females spend more time with males in larger groups, compared to anestrus females. However, little is known of changes in female-female social relationships across the cycle. This study examines whether and how female-female associations change across reproductive states. Focal behavioral data were collected on female chimpanzees (n=14) at Taï between 1998-2001. Females were observed monthly in each reproductive state, which was classified based on sexual swelling size using a scale from 0 (detumescent) to 4 (maximal tumescence). Female social preferences were based on party association scans, which were taken every 10 minutes. Preferred associations and group dynamics were analyzed in SocProg and UCInet. Dyadic association rates were compared for individual females (n=9) across reproductive states. Preliminary results indicate that females have different association patterns in and out of estrus. When at least one female is in estrus, parties have a higher association index and there is an increase in female-female associations. Determining how female association patterns change across reproductive state is important for understanding female sociality and the costs of reproduction.

Max Planck Institute for Evolutionary Anthropology, NSF, UIUC Research Board.

#### The evidence of medicinal plant use in prehistoric humans from an archaeological site in Northeastern Brazil

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This work seeks to assist in understanding the habits, cultures, preferences and strategies that were used by prehistoric groups through the identification of food remains found in the diet, the analysis of environmental conditions and identifying consumed plants, to understand the paleopharmacopeia. The coprolites and sediment samples of individuals buried at Furna do Estrago provided the necessary conditions for this type of work. The results were integrated in order to allow verification if the group were doing some kind of treatment for helminths due to the symptoms they probably felt at the time. Data on the lifestyle and habits of prehistoric populations in the Northeast are still sparse. Thus, the study of prehistoric groups offers the opportunity to deepen understanding of human

adaptation and settlement in the region. The results of these analyses contribute to studies on paleoenvironment, paleonutrition and paleoparasitology, since food items were found composing a diet rich in vegetables, and pollen grains with medicinal properties were found in samples that were positive for parasitological examination. In addition it was possible to demonstrate the differences in eating habits between men and women of the prehistoric group that inhabited the archaeological site, showing an increased occurrence of starchy foods in the male diet.

capes

#### Lateralization and Performance Asymmetries in the Termite Fishing of Wild Chimpanzees in the Goulougo Triangle, Republic of Congo

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The nearly universal right hand preference manifested by human populations is one of the most pronounced manifestations of population-level lateralization. Morphological and archeological evidence indicate that this behavioral specialization may have emerged among our hominin ancestors. Whether population-level behavioral asymmetries are evident in non-human animals remains a topic of considerable scientific debate, with the most consistent evidence of population-level trends emerging from studies of chimpanzees (*Pan troglodytes*). However, previous studies of population-level lateralization in wild apes have relied upon data sets pooled across populations to reach adequate sample sizes. Our aim was to test for population-level handedness within a single wild chimpanzee population, and also to determine if performance asymmetries were associated with handedness. To address these questions, we coded handedness and duration of fishing probe insertions from remote video footage of chimpanzee visitation to termite nests (totaling 119 hours) in the Goulougo Triangle, Republic of Congo. Similar to reports from other populations, chimpanzees in the Goulougo Triangle showed robust individual hand preferences for termite fishing. There were 46 right-handed, 39 left-handed and 4 ambiguously-handed individuals. Though we did not detect an overall significant population-level handedness ( $t(88)=0.83$ , n.s.) in this study, males showed a greater right hand preference than females. Further, we found that average dipping latencies were significantly faster for right- compared to left-handed chimpanzees. Possible explanations and evolutionary implications of taxa- and task-

specific patterns of population-level laterality are discussed.

#### Dental health in a wild population of ring-tailed lemurs (*Lemur catta*) at the Beza Mahafaly Special Reserve and Tsimanampesotse National Park, Madagascar

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We present patterns of dental pathology within the context of feeding behavior, habitat variation and anthropogenic effects on wild ring-tailed lemur populations living in disparate habitats, the Beza Mahafaly Special Reserve (BMSR) (2004 – 2010), which has both intact gallery forest and anthropogenically altered areas that include human croplands and degraded forest, and Tsimanampesotse National Park (TNP) (2006) which contains intact spiny thicket. These lemurs demonstrated a variety of dental pathologies including a high incidence of toothcomb plaque, heavy canine calculus with gingivitis and, more rarely, cavities. A cyclone in 2006 that toppled trees and reduced food resources at BMSR were accompanied by a much higher incidence of dental pathologies than other years ( $X^2$  (DF = 84, N= 127) = 118.37,  $p < .008$ ). In addition, females had a higher percentage of pathologies that year compared to males ( $X^2$  (DF = 1, N = 72) = 4.68,  $p < .03$ ). Behavioral variation such as crop-raiding also affected patterns of pathology, with crop-raiding troops exhibiting higher percentages of pathologies ( $X^2$  (DF = 1, N= 370) = 12.10,  $p < .0007$ ). Different habitats were associated with different pathologies, with caries, molar staining and heavy canine calculus characterizing TNP lemurs, and toothcomb plaque, heavy canine calculus plus gingivitis more prevalent at BMSR. Comparing these results with sub-fossil lemur specimens indicates similar pathologies existed for extinct taxa. Thus, studies of living populations can also be useful in providing ecological context for understanding fossil primate dental health.

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#### Selection gradients and ecogeographic variance in the human post-cranium

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Recent work by Roseman and Auerbach (*in press*) indicates that the ecogeographic distribution of human body proportions is driven

by a combination of neutral evolutionary forces and natural selection. This contrasts with assumptions that natural selection produced morphological variance equated with ecogeographic patterns (i.e., Bergmann's and Allen's "rules"). Roseman and Auerbach's approach, however, could not distinguish between direct and indirect responses to the natural selection acting on these morphologies. This study uses retrospectively estimated selection gradients of post-cranial dimensions (limb lengths, femoral head size, and body breadth) to assess the nature of non-neutral evolutionary forces on ecogeographic variance in human morphology.

We analyzed vectors of retrospectively estimated selection gradients required to evolve one group into another for pairs of populations across major climate regions of the world. Parametric bootstraps were used to estimate 95% confidence intervals. We assume that equatorial African populations have been drifting atop a plateau on the adaptive landscape, reflecting a tropically adapted human state. Results indicate that strong selection on distal limb lengths, femoral head size, and body breadth effected an evolutionary transition to morphologies found in populations inhabiting the arctic. The patterns of selection necessary to effect a transition to states found in more temperate regions (i.e. North Africa and Europe) were qualitatively similar but much less strong. These results support Roseman and Auerbach's findings in part, but suggest that the action of natural selection on one hand and random genetic drift, gene flow, and neutral mutation on the other may be entangled.

#### **Quasi-complex cooperative strategies of Argentine tufted capuchin monkeys**

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Theoretical arguments suggest that collective male resource defense is difficult to maintain. Yet among tufted capuchin monkeys (*Sapajus nigritus*) at Iguazú National Park, Argentina, dominant and subordinate males are equally likely to lead intergroup aggression over high quality resources. To understand the potential benefits to males, I performed a principal components analysis, using behavioral data collected through instantaneous focal animal sampling ( $N = 130.7$  hrs), to create sociospatial profiles for 12 adult and subadult males. Leadership among males is best predicted by the asymmetry in male group size in combination with its interaction with male social and spatial integration. Examining individual sociospatial profiles for individual males suggests that with regards to leadership, adult male tufted capuchins exhibit two of the previously described patterns of cooperation described for female lions. Individuals fall either into the category of "unconditional cooperators" ( $N = 5$  males) or "conditional laggards" (i.e., individuals that participate only when the numerical odds

favor their group;  $N = 7$  males). In contrast to the few studies of other primate species, these categories are not indicative of male rank, as measured via cardinal rank or a simple dichotomy between dominant and subordinate males. Among subordinate males, "unconditional cooperators" appear to be individuals that are more spatially integrated, yet remain socially isolated. A third category, "unconditional laggards" is accounted for by juvenile males, as expected given their smaller body sizes. These results suggest that male behavioral strategies during intergroup encounters may be linked to differences in temperament or personality.

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#### **Teaching with ePortfolios**

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This research investigated the use of ePortfolio reflective pedagogy to improve students' critical thinking skills. Intentional and deep reflection encourages students to make meaning from diverse learning experiences and to connect and integrate their learning across disciplines and time. Published studies report that ePortfolios enhanced students' synthesizing and organizing of ideas and information in new ways – hallmarks of critical thinking. A college-wide assessment of critical thinking was conducted by two-person review teams using modified components of AAC&U's Critical Thinking VALUE 1-4 point rubric (3=meets expectations) to score, by consensus, the first three and final three reflective assignments in student ePortfolios. A single critical thinking criterion (making connections, offering new insights and perspectives, and/or uses techniques such as questioning, comparing, interpreting, analyzing) was used. The mean score for students' first three ePortfolio reflections was 2.4 and for their final three ePortfolio reflections was 1.91; both mean scores were below expectations. In a separate assessment, individual instructors evaluated only introductory biological anthropology ePortfolio assignments using a 1-4 point rubric with separate criteria for interpretation, analysis, evaluation, and inference. Results found that 85% of biological anthropology ePortfolio assignments met or exceeded expectations for critical thinking. Whether the difference between the two assessments can be explained by differences in assessment methods, the nature of the ePortfolio assignments themselves (which vary from professor to professor), or some other factor remains to be tested. Future research will evaluate pre- and post-reflection critical thinking to more effectively assess the success of ePortfolio reflective pedagogy.

#### **Evidence for selection in human populations for Black/Dark Brown hair color using Phenotype Informative Markers**

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Using SNP data from individuals with a phenotype of black or dark brown hair (African American [19], East Asian [17], European [18], South Asian [25] and Hispanic [6]), the distribution of hair color genotypes was compared to the total study samples. Under the central limit theorem, there should be no variation of genotypes in the small hair color specific sample versus the large population samples. Fst data was generated on 42 pairs of AIMs, 46 pairs of PIMs and 9 TIMs, and compared using Chi-square.

For each SNP the population with the major effect was noted and if the hair population was the same as the total population they were scored as a match, if not a mismatch. For the AIM and TIM loci there were respectively 41 and 8 matches and 1 mismatch each, for PIM loci there were 18 matches and 28 mismatches. The AIM and TIM were pooled and significantly different from the PIMs ( $X^2 = 36.716$ , 1 df,  $p = 0.0000$ ). Further, the distribution of PIM mismatches was significant across loci ( $N = 17$ ) ( $X^2 = 29.346$ , 16 df,  $p = 0.0217$ ). Eight loci had more matches than expected, while nine loci had more mismatches than expected. The two groups were pooled and tested ( $X^2 = 27.619$ , 1 df,  $p = 0.0000$ ). These data suggest that in high sun intensity areas there has been selection for different darker hair pigmentation pathways. The deviations from expected values under the central limit theorem appear to be a simple way of detecting selection.

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#### **Sex Estimation from Juvenile Human Crania: A Validation of Gonzalez (2012)**

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Sex determination is fundamental for constructing biological profiles in archaeological and forensic settings; however, sex estimation from juvenile human skeletal material remains difficult. Recent studies have pointed to the onset of sexual dimorphism in the cranium during childhood, before the development of secondary sex characteristics. Gonzalez (2012) presents a method for sex estimation using cranial measurements from lateral cephalometric

radiographs utilizing canonical discriminant function analysis. The sex classification equations produced from these analyses are tested here on a comparable sample.

Lateral radiographs of individuals of European descent aged 5 – 16 years from the Denver Growth Study ( $n = 75$  male scans,  $n = 80$  female scans) were assessed. Scans were uploaded in digital format to ImageJ, where the 20 measurements were recorded from 8 standard craniometric points. Following Gonzalez (2012), individuals were sorted into six 2-year age-groups (5-6 year-olds, 7-8 year-olds, etc.), and subjected to the appropriate discriminant function equations for their age cohort.

Overall, sex classification in this sample ranged from 53 to 78% accuracy, achieving less accuracy than Gonzalez's results, with the models more accurately classifying males than females in most age categories. Interestingly, the classification equations for the youngest group, 5-6 year olds, and the oldest group, 15-16 year olds, performed best on this sample (M:11/13, F:10/14 correctly classified; M:6/10, F:12/14 correctly classified, respectively). These results demonstrate the utility of craniometric measurements for sex estimation of juvenile humans, and encourage further research into the ontogeny of sexual dimorphism in the cranium during childhood and adolescence.

#### **Pathological traits in Neolithic skeletal remains – Earliest evidence for leukemia?**

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Abnormalities on human skeletons in archeological series attract interest, provoking questions about their origin. Do they represent a rare medical condition, an inherited trait, or a combination of both? The appearance of pathological cases shed light on the health status of prehistoric populations and give us a first hint about the evolution of a disease.

We present a skeleton from the Neolithic site, Viesenhäuser Hof' in SW Germany. Although the specimen showed no signs of severe pathologies under standard morphological assessment, investigations on the skull, humerus, sternum, vertebrae, phalanges, pelvis, and femur using high resolution CT scanning (GE vltomelx s, University of Tübingen Paleoanthropology High Resolution Computed Tomography Laboratory) revealed a pattern of profound loss of trabeculae in both humeral and sternal cancellous bone.

This high level of internal resorption of cancellous bone is significantly different from specimens from the same site and from recent individuals. It is characteristic of endocrine disorders and neoplastic conditions. At the site of, Viesenhäuser Hof' already one individual with symptoms of primary hyperparathyroidism, an endocrine disorder causing disintegration of cancellous bone, was found. The affected locations in the present case, however, correspond better to a neoplastic condition. The locally defined bone resorption in the sternum and humerus cancellous bone strongly suggests leukemia in initial stages, affecting the hemopoietic stem cells in bone marrow. If our interpretation is correct this case is the earliest known appearance of leukemia.

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#### **The Effects of Climatic Trends, Variability, and Rates of Change on Mammalian Brain Evolution**

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Explanations for the dramatic brain size increase observed in the hominin lineage have inspired a wide variety of competing explanations for this hallmark evolutionary event. Large-scale climatic hypotheses have traditionally focused on either 1) the effects of consistent trends towards cooler temperatures, aridity, or increasing proportion of C4 vegetation, or 2) increasing variability in these climatic variables. However, this assumes a false dichotomy between these models of climatic selection when it is far more likely that these interrelated types of global climatic change are neither mutually exclusive nor the only factors that drove hominin encephalization. Furthermore, almost all tests of these hypotheses to date have investigated hominin specimens to the exclusion of other mammalian taxon. The present study sought to quantify the relative contribution of consistent trends, variability, as well as rates of climatic change across a wide variety of hominin and non-hominin mammalian species in order to more comprehensively understand the effects of global climate on brain size as a general principle of mammalian evolution. Results revealed that climatic Variability, Trend, and Rate (in terms of both temperature and vegetation) have all served as indirect drivers of mammalian brain expansion, albeit not for every mammalian taxa at every point in time. Furthermore, hominin cranial capacity was most strongly correlated with climatic trends towards global cooling. These results indicate that global-scale climatic variables played significant and not necessarily mutually exclusive roles in hominin and non-hominin mammal brain evolution.

#### **The use of linguistic data in bioarchaeological research: an example from the American Southwest**

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It has been suggested recently that the genes and languages of prehistoric cultures inferred from the archaeological record in the American Southwest need not have co-evolved as packages, as is commonly assumed. The purpose of the present research is to assess this notion of co-evolution by examining the concordance of linguistic and genetic relationships among ancestral and present-day Tanoan-speaking Pueblo Indians of the Northern Rio Grande Valley of New Mexico. In order to estimate the relationships among languages we generated pair-wise measures of lexical dissimilarity among present-day Tanoan languages based on a 40-word subset of the Swadesh 100-word list using the Automated Similarity Judgement Program. To estimate genetic relationships we generated biological distances using craniometric data. The craniometric data were derived from skeletal populations known to be directly ancestral to the same pueblos from which the linguistic data were derived. We generated neighbor-joining trees using these distance matrices, and conducted a series of distance matrix correlation analyses (Mantel tests) to test a simple isolation by distance model. Although the trees describing linguistic and biological relationships exhibited moderate concordance, the results of the Mantel test indicated there was not a significant relationship between linguistic and biological distances ( $r=0.309$ ,  $P=0.171$ ). The isolation by distance model was rejected for both language ( $r=0.520$ ,  $P=0.068$ ) and biological relationships ( $r=0.305$ ,  $P=0.094$ ). These results support the notion that linguistic and biological coevolution has not occurred historically among the Tanoan Pueblos. Furthermore, linguistic and biological relationships do not seem to have been mediated by geographic distance.

#### **Age-related changes in human mandible shape**

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For assessing age-related shape changes in the human mandible, two factors were considered: shape changes associated with tooth-loss and general aging. Using CT-scans, automated landmark and surface mesh extraction of the mandible was performed on 115 individuals from Germany and China. As the Chinese individuals were only little affected by tooth-loss, even at



very old age, they served as control group for age-related changes not attributed to tooth-loss. The German sample, however, showed severe tooth-loss for older individuals.

The landmarks were used to establish an initial spatial orientation within the sample. Based on this information surface registration was performed by applying an elastic ICP-Algorithm consisting of two parts: An iterative Gaussian smoothed deformation is performed with the resulting deformation being additionally regularized by minimizing deformation energy. Due to ambivalent quality of the CT-data in the condylar region and the coronoid processes, as well as the inconsistent presence/absence of teeth, these areas were excluded from further statistical analyses.

After correcting for population differences, the resulting set of registered coordinates was statistically evaluated for effects of aging. The predictor *age* provided a high explanatory value within the German sub-sample and a low one in the Chinese data. Visualizations show a similar pattern in both populations in the gonial region. But, while these are the only shape differences among Chinese individuals (not affected by tooth-loss), the German sample exhibits significant “shrinkage” of the corpus mandibulae, when compared to the rami, owed to atrophication caused by tooth-loss.

**Maternal effects influence the heritability of adult obesity traits but not obesogenic growth trajectories in vervet monkeys (*Chlorocebus spp.*)**

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There are known maternal effects on obesity outcomes in humans and nonhuman primates, but few have investigated these effects on obesogenic growth throughout the lifespan. To investigate the impact of maternal effects on the genetic underpinnings of obesogenic growth we used growth curve analysis on measures taken thrice yearly from 2000 to 2013 on body size and composition in a captive population of 641 vervet monkeys (*Chlorocebus spp.*). Of these, 38 were defined as chronically obese, having had an adult waist circumference above 40.5 cm for three successive measurements. Growth was modeled using three-parameter logistic growth curves in nonlinear mixed models, with parameters modeled as fixed and subject and

sex/obesity status modeled as random effects. We assessed heritability of individual growth parameters using SOLAR, with the variance attributed to maternal ID ( $c^2$ ) partitioned from environmental variance to determine maternal effects. We found significant heritability and maternal effects on all static measures of adult body condition (e.g., BW,  $h^2=0.86$ ,  $p=6.52 \times 10^{-10}$  and  $c^2=0.11$ ,  $p=0.04$ ; BMI,  $h^2=0.77$ ,  $p=1.39 \times 10^{-09}$  and  $c^2=0.12$ ,  $p=0.05$ ), and high heritability but no significant maternal effects on parameters of growth (e.g., BW, asymptote of growth,  $h^2=0.77$ ,  $p=4.93 \times 10^{-21}$  and  $c^2=0.05$ ,  $p=0.11$ ). This study suggests that although adult obesity is a developmental process driven in part by heritable obesogenic trajectories resulting in larger adult size, those trajectories do not appear to be influenced by maternal effects. A better understanding of how growth can be decoupled from maternal effects on adult obesity will be necessary to assess early obesity risks.

**Three dimensional cut mark analysis in order to discern ancient cutmark tools**

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This study employs a White Light Confocal Profiler to analyze both experimental and archaeological cutmarks. All analyses used SolarMap® software and a Sensofar Pljü profiler. Surfaces were scanned in multiple profile mode at 10X with cuts oriented so that they were vertical on the screen. Two dimensional data acquisition followed procedures developed previously (Schnellenberger and Schmidt 2014). For 3D study, analysis took place using the ‘volume of hole/peak’ option, which rendered kerf surface, volume, maximum, and mean depths data. The sample included cut marks from archeological samples (Middle and Late Archaic people from the eastern US), as well as experimental cuts made with ground stone celts, chert bifaces, and modern trowels. Experimental cuts were made by placing tools in a clamp and dropping them down a steel post from a standard height to impact a cow ribs. The results indicate ancient cuts were very wide relative to their depths. In 3D, they have large volumes and large mean depths. Cut marks from celts were most similar to the ancient cuts. Some bifaces made large cuts, but on average their cuts were smaller. The steel trowel cuts (which were made by hand) were very narrow by comparison. It appears the ancient cutmarks were made with large stone tools, like ground stone tools, and were not made with fine bladed implements. It is also clear that the cuts were not the result of excavation.

**Estimated total time spent in social play prior to adulthood is strongly associated with brain size in primates**

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Play behavior is of considerable evolutionary interest. The energetic costs and increased likelihood of injury suggest play confers an evolutionary benefit. A number of comparative studies of primates have shown that typical percent of time spent in play (%PLAY) correlates with the sizes of various interesting brain components, including overall brain size. Brain size also correlates with measures of social complexity, suggesting that play functions as a means to learn adult social behaviors. However, %PLAY reportedly does not correlate with maturation time, even though this latter measure also correlates strongly with brain size.

Previous studies used a frequency measure (%PLAY) rather than total time spent playing prior to adulthood. It is possible that species that mature more rapidly given their brain size tend to compensate by playing more frequently (and vice-versa for species that mature more slowly). If so, brain size would correlate more strongly with total time spent playing prior to adulthood. This was tested on a sample of 18 primate species for which %PLAY, age at menarche, and brain size was available in the literature. Total time spent playing prior to adulthood was estimated by multiplying %PLAY by age at menarche. This measure correlated more strongly with brain size ( $r=0.94$ ,  $p<0.0000001$ ) than did %PLAY ( $r=0.90$ ,  $p<0.000001$ ), though both were highly significant. This association remained after controlling for phylogenetic relatedness using PGLS. Furthermore, the slope of the relationship was close to one (1.108), indicating that total time spent playing scales approximately isometrically with brain size.

**Vervets in an anthropogenic landscape: Reduced breeding seasonality and mixed diet**

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The availability of food could significantly impact female reproduction, and seasonal variation in this resource can influence the timing of reproductive events. Here we examine the relationship between food availability and the timing of births in vervet monkeys (*Chlorocebus pygerythrus*) living in a forest-agriculture matrix at Lake Nabugabo, Uganda. We examined 26 births from 11 adult females over 3-years in relation to resource availability in this modified landscape, where natural foods are supplemented

by crop-raiding, food-raiding, and tourist handouts. In contrast to other study sites, where vervets are classified as strict seasonal breeders (> 67% of births in 3 month period), the Nabugabo vervets are moderate seasonal breeders (33-67% of births in 3 month period). They experienced two birth peaks (May-July, and October-December), with each 3-month peak accounting for ten births (38%). Furthermore, females who had an infant that survived to 6 months of age (n=18) and who subsequently gave birth had mean interbirth intervals approximating one year ( $368 \pm 97$ , range 241-550 days; n=12), which is similar to what has been reported for vervets in other locations. The reduced breeding seasonality at Nabugabo may be associated with less variation in food availability and access to energy-dense human foods, suggesting that females rely partly on internal cues (i.e., body condition) to time reproductive events.

**The Crypt People from the Cathedral Basilica of Saints Stanislaus and Vladislaus, Vilnius, Lithuania: Reconstruction of Life Histories using Stable Isotope Analysis**

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Stable isotope analyses of multiple tissue types have been used to reconstruct life histories of individuals from past populations. Here we present the results of stable isotope analysis from a unique population recovered from a 16th to 18th century cathedral crypt located in Vilnius, Lithuania. The sample consists of 23 individuals (21 males, one possible female, and one juvenile). Analyses were performed on collagen from bone and dentin, and on hydroxyapatite from bone and enamel; resulting in eight isotope values per individual, providing both childhood and adult dietary and migration information. For bone collagen the average  $\delta^{13}\text{C}$  isotope ratio is  $-19.88\text{‰} \pm 0.41$  and for  $\delta^{15}\text{N}$  is  $11.80\text{‰} \pm 0.87$ . The average  $\delta^{13}\text{C}$  isotope ratio for collagen extracted from dentin is  $-19.54\text{‰} \pm 0.49$  and for  $\delta^{15}\text{N}$  is  $11.45\text{‰} \pm 0.92$ . The bone apatite average  $\delta^{13}\text{C}$  ratio is  $-14.97\text{‰} \pm 0.81$  and the average  $\delta^{13}\text{C}$  enamel ratio is  $-13.88\text{‰} \pm 1.48$ . These values indicate a diet in both early childhood and adulthood that was heavily reliant on  $\text{C}_3$  plants; a result supported by previous isotopic studies from Lithuania and surrounding countries. The average  $\delta^{18}\text{O}$  bone apatite ratio is  $-14.79\text{‰} \pm 0.36$  and the average enamel  $\delta^{18}\text{O}$  ratio is  $-8.56\text{‰} \pm 2.82$ . The  $\delta^{18}\text{O}$  isotope values suggest that 15 of these individuals were born elsewhere and migrated to the city of Vilnius after their childhood years. Stable isotope analyses, in combination with macroscopic

examination, aids in the understanding of those who were buried in this unique location.

**Physical anthropology education and undergraduate students' socioscientific decision-making and interest in science**

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In the U.S., there is a national agenda to increase numbers of qualified STEM professionals and a movement to promote science literacy among the public. This project explores the association between formal human evolutionary biology education (HEB) and high school (HS) science class enrollment, interest in a STEM degree, motivation to pursue a STEM career, and socioscientific decision-making. The Grounded Theory Method was the foundation for a mixed-methods analysis of qualitative and quantitative data from interviews, focus groups and a survey. The survey, developed to test hypotheses, was completed by 486 ASU undergraduates, age 18-22, who graduated from U.S. public HS.

Higher HEB exposure correlated with greater HS science enrollment and, for some students, HEB may have influenced enrollment because students found content interesting and relevant. Results suggested students with more HEB felt more prepared for undergraduate science coursework. There was a positive correlation between HEB and interest in a science degree and an indirect positive relationship between HEB and motivation to pursue a science career. Regarding socioscientific issues, including but not limited to climate change and stem cell research, students' decision-making more closely reflected a scientific viewpoint—or less-closely aligned to a religion-based perspective—with greater HEB, but this was sometimes contingent on lifetime exposure to religious doctrine and acceptance of evolution.

This study has implications for K-12 and higher education and justifies a paradigm shift in evolution education research, focusing on students' interests, academic preparation and goals, and potential societal contributions, rather than just evolution knowledge and acceptance.

**The relative importance of adaptation versus genetic drift in driving diversification in *Homo***

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New fossil finds have fuelled the ongoing phylogenetic debate surrounding the evolution of early *Homo*, and highlight the remarkable variation and diversity present at the time of emergence of our genus. Previous interpretations

of this diversity have focused on scenarios of adaptation, rarely considering the contributions of gene flow and genetic drift, or the possible roles of vicariance and dispersal. Understanding the action of these underlying processes on our lineage is an essential step in identifying probable evolutionary scenarios, and provides further evidence informing possible relationships between species. Here, we use statistical tests developed from quantitative genetic theory to test whether genetic drift (as opposed to selection) could be responsible for the cranial and mandibular variation observed in *Homo*. Analyses are performed on 3D scan data collected from early and later *Homo* specimens from eastern and southern Africa, Dmanisi, Georgia, as well as Java, Indonesia. Results indicate that in 90% of cases the cranial and mandibular phenotypic diversity seen between these geographical and spatially separated *Homo* groups is consistent with genetic drift. Rejections of drift, signifying possible selective forces, are associated with the Dmanisi hominins, as well as southern African early *Homo*, suggesting that these hominins at the latitudinal extremes of the early *Homo* range are adapting biologically to these different environments. This indicates that adaptation was important in the early migration of *Homo* out of Africa, and that geographically separate populations of *Homo* marshalled different responses (i.e. biological versus cultural) to environmental pressures.

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**Ecological niche reconstruction of *Homo* taxa in the Late Pleistocene**

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Modern humans share a percentage of their DNA with Neanderthals and Denisovans, and this genetic introgression suggests that the ranges of several *Homo* taxa may have overlapped in the Late Pleistocene. Ecological niche reconstruction can help determine the most likely range distributions for these hominins and assess how stable environmental locations (i.e., refugia) may increase range overlap. Elevation, perturbation, precipitation, pressure, surface temperature, and vegetative variables for hominin fossil sites from 60-30K were extrapolated from Singarayer and Valdes (2010)'s simulation of the last glacial-interglacial cycle. These variables were inputted to the Maxent program, which models species habitats and potential ranges using an iterative algorithm to determine the likelihood of occupation. Using 155,000 background points in each of four 10K time slices, the results of this analysis indicate that Denisovans may have been restricted to Central Asia in an area north of modern India and bordered by modern Uzbekistan and the Pacific Ocean. Habitats

suitable for Neandertals and anatomically modern humans are more global in their range, with coastal habitats of Africa and South Asia particularly favorable to anatomically modern humans. Based on the variables and parameters of this reconstruction, Central Asia appears particularly inhospitable to anatomically modern humans. This result suggests that hybridization between Denisovans and anatomically modern humans may have occurred on the peripheries of the Denisovan range and provides one example of how ecological modeling may improve our knowledge of when and where genetic introgression may occur.

**Frequent leaping origins: unpredictable substrate orientation and position as the selective context for euprimate visual system improvements**

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Primates are a highly arboreal clade characterized universally by grasping appendages and hind-limb dominated climbing. Plesiadapiform fossils recently unearthed in North America implicate grasping as predating orbital convergence (and hind limb elongation) -- suggesting that leaping, a behavior hypothesized to provide the selective context for such morphology, may have been a penultimate step in the evolution of the primates of modern aspect (Euprimates). Other theories such as "visual predation" and "camouflage breaking" also predict these vision changes but can additionally accommodate for the fact that the benefits of binocular parallax are limited to close range targets. I hypothesized that these close range preferences could be advantageous late in a leaping bout when exigently determining appropriate limb positioning and grasp orientation for safe landing (as destination substrate configuration may be unknown or ambiguous during take-off). Because precise knowledge of early primate leaping behavior is currently unavailable, I compiled quantitative locomotor estimates for 103 species (from 42 source studies) and performed ancestral character estimation [ACE] on them to calculate a phylogenetically-weighted, average leaping frequency for the ancestral Euprimate. My analysis suggests that the first true primates had repertoires with leaping composing nearly half (47%) of their locomotor bouts, strongly supporting a leaping-based theory of Euprimate morphological origins. Future origins models might benefit from a composite approach whereby elements are incorporated from multiple theories (e.g. leaping as a mechanism of snake predation avoidance).

**Genetic Diversity and Population History in Svaneti, Northwestern Georgia**

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BITADZE<sup>4</sup>, DAVID CHITANAVA<sup>4</sup>, SHORENA LALIAHVILI<sup>4</sup>, IRMA LALIAHVILI<sup>4</sup>, AKIVA SANDERS<sup>1</sup>, ANDREW AZZAM<sup>1</sup>, VICTORIA GRONER<sup>1</sup>, KRISTI EDLESON<sup>1</sup> and MIGUEL VILAR<sup>1</sup>. <sup>1</sup>Department of Anthropology, University of Pennsylvania, <sup>2</sup>Department of History and Social Sciences, Bryn Athyn College, <sup>3</sup>Department of History of Medicine and Bioethics, Tbilisi State Medical University, <sup>4</sup>Institute of History and Ethnology, Tbilisi, Georgia.

In this analysis of the genetic diversity and ethnohistory of Svans, a highland population from northwest Georgia, we evaluated a number of important questions concerning population histories in the South Caucasus. To what extent have the current inhabitants of the Caucasus descend from Upper Paleolithic populations? How did the dispersal of Near Eastern agriculturalists into Georgia affect the region's genetic diversity? Did changes in social organization and culture during the Bronze Age of the Caucasus reflect an influx of new settlers into the region? To what extent do geographic boundaries of language-affiliation mirror genetic patterning? To address these questions, we analyzed mtDNA and Y-chromosome variation in 200 Svan and Georgian individuals, and compared the genetic data with ethnohistorical evidence from Svaneti. We observed a predominance (~70%) of one major paternal lineage in Svans, haplogroup G2a, with others (I, J, and R1) being present at lower frequencies. From a maternal genetic perspective, we noted a wide spectrum of mtDNA diversity in Svans, with haplogroups C, H, HV, J, K, M1, N1b, T, U1, U3, U4, U7, W and X2 being present. These data reveal strong genetic similarities between Svans and neighboring Ossete and Abkhaz (both non-Kartvelian-speaking) populations, but also distinct patterns of mtDNA and Y-chromosome variation in them. Our results provide new insights into anthropological genetic variation in the South Caucasus, and will help to situate Georgian history more firmly within the broader context of the Caucasus and Near East.

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**Death in the City – Differential non-adult mortality in post-medieval London**

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Human male excess mortality in non-adult age groups is an established empirical observation commonly linked to the X-chromosome-related favourable survival prospects of females. The extent of male disadvantage is dependent on

various socio-ecological conditions and thus differs within and between societies. For archaeological populations, mortality differentials have been extensively studied as age-related trends; however, biological sex of juvenile individuals is perpetually being excluded, despite confirmation of suitable methods for the assessment of sub-adult sex from skeletal indicators, rendering the interpretation of non-adult mortality incomplete.

We present results of a study examining a total of 480 non-adult individuals from four cemetery populations of ascribed high and lower socio-economic status in London, dating to the 18<sup>th</sup>-19<sup>th</sup> century, to ascertain patterns of sex-differential mortality across the early life course. Overall, mortality sex ratios (MSR) were found to be greater in girls, yet with the exception of the foetal/perinatal and later childhood/adolescent periods, when male mortality was higher. At all sites, female mortality outweighs male mortality in infancy and early childhood, with peak MRS between one and five years of age. Significantly, this pattern prevails irrespective of socio-economic status (SES) of the populations studied. Girls of both high and low SES have similar mortality rates, while boys of low SES are much more affected in this age group than those of high SES. Conversely, male MRS of adolescent boys peaks in high SES populations. The findings are discussed against predictions from behavioural ecology in the context of London during the heydays of industrialisation.

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**Kennewick Man: paleodiet, and the people of the Pacific Northwest Coast**

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Kennewick Man (KM), dated by <sup>14</sup>C to 9,005 ± 70 y BP, is one of the most complete ancient human skeletons found in North America. Morphological studies suggest that he was not genetically related to other Native American populations but ongoing aDNA studies should clarify his genetic affinities. Starting in 2004, a new collaborative study of his remains was



undertaken, led by D. Owsley and R. Jantz. Using carbon and nitrogen isotopic analyses of collagen extracted from bone, we found that the protein component of KM's diet for at least the last decade of his life was exclusively high-trophic-level marine animals, including salmon and marine mammals. He apparently did not consume the meat of terrestrial herbivores, although these were plentiful locally. In these respects his diet closely resembles a population of more than 100 indigenous people from British Columbia (Schwarz et al., *AJPA*, 2014), who range in age back to 6000 BP, and other more recent indigenous remains from Alaska. He differs, however, from people of the BC interior who included land animals in their diet. We speculate on the significance of these dietary practices.

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### **The evolutionary history of hominin growth, life history, and energetics**

GARY T. SCHWARTZ. Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University.

Life history theory explains variation in the pace of life as the outcome of how selection operates on a series of trade-offs in the allocation of an organism's energetic budget. Mammalian life histories lie along a spectrum with endpoints termed "live fast, die young" and "live slow, die old." Human life history incorporates elements of both schedules: long gestation, altricial offspring, enlarged brains, slow maturation rates, increased lifespan, and protracted periods of offspring dependence suggest a "live slow" strategy, whereas relatively early weaning, short interbirth intervals, and the ability to overlap births (resulting in the presence of multiple offspring) suggest a "live fast" schedule. Understanding when, and under what conditions, selection assembled this unique package of life history attributes is central to reconstructing the ecological, demographic, and energetic constraints that have shaped what it means to be human.

In this review, I highlight what is known, unknown, and perhaps unknowable about the evolution of hominin life history by synthesizing data from studies on extant primate biorhythms, dental development, isotopic and dietary ecology, reproductive biology, and comparative energetics. Combined data suggest that models reconstructing all early hominins as possessing apelike life histories are likely too simplistic and ignore subtle differences in how large-bodied, large-brained apes differentially allocate energetic resources to reproductive scheduling (weaning) and overall growth. A model will be presented demonstrating that varying life history strategies likely characterized major australopithecine groups and early/late species of *Homo*, and were

tuned to localized differences in diet, ecology, and energetic budgets.

### **Assessment of lesions of the rotator cuff (Rotator Cuff diseases (RCD))**

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The shoulder joint is one of the most mobile and flexible ones in the human body controlled and fixated mainly by the subscapularis, supraspinatus, infraspinatus muscles as well as teres minor muscle, altogether referred to as the rotator cuff. It often shows lesions on the human skeleton, mostly on the attachments of the aforementioned muscles. Age, as well as the impact of trauma, and simple wear can play a role in their emergence. Symptoms can be as simple as a display of osteophytes in combination with pitting or porosity, or, depending on the severity of the lesion, the appearance of cysts beneath the joint surface. This common lesion has been researched, reviewing modern samples as well as several populations from Bronze Age Caucasus / Russia. In 85 individuals with preserved proximal humerus 56 individuals (65.9%) exhibited pathological changes, slightly more frequently on the right than on the left side. In these samples, the occurrence of RCD seems to be age- but not sex-dependent. The most often effected muscle was the subscapularis muscle (84.4% of the right side, 90.9% of the left side). Samples were examined using macroscopy as well as x-ray technology, histology and scanning electron microscope examination in certain ancient cases. By connecting modern and ancient cases a better understanding of the emergence and manifestation of RCD should be achieved.

### **A Baffling Convergence: Tooth Crown and Root Morphology in Europe and New Guinea**

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European and New Guinea populations are polar opposites for a wide range of biological characteristics, including body size, skin color, hair color and form, and numerous genetic markers. An analysis of 23 tooth crown and root traits in 53 samples from the New World, Northeast Asia, Southeast Asia, Polynesia, Australia, Melanesia, New Guinea and Europe clusters four New Guinea samples with five European samples, at some remove from the next most closely related groups (Australians, Melanesians, Southeast Asians). An ordination based on principal components analysis shows the same result with European and New Guinea samples in the same quadrant, set apart from Australia and other Pacific populations. Europe

and New Guinea share in common a high frequency of 4-cusped lower molars but even when this trait is removed, the convergence of the two geographically disparate groups remains. In most instances, dental morphological trait frequencies produce patterns of affinity closely congruent with genetic markers. In this instance, results are quite the opposite. This finding may or may not fall under the dictate of 'cherish your exceptions' but it does make for a challenging interpretation.

### **Patterns of premolar molarization in platyrrhine and catarrhine primates**

JEREMIAH E. SCOTT and RYAN M. CAMPBELL. Department of Anthropology, Southern Illinois University.

In contrast to the many studies demonstrating consistent associations between diet and aspects of incisor and molar morphology among primates, the functional significance of variation in premolar morphology remains poorly understood. Molarization, or enlargement, of the premolars has been linked with both folivory and hard-object feeding, but such relationships lack comparative support. This study tests the hypothesis that premolar enlargement presents a consistent dietary signal across anthropoid primates that distinguishes members of broad dietary categories (i.e., frugivores, hard-object feeders, folivores). We examined the relationships between linear dimensions of the premolar row and dietary categories in a large sample of extant anthropoid primates ( $n = 89$ ) using phylogenetic generalized least squares. Separate analyses were conducted on catarrhines and platyrrhines, on males and females, and using body mass and palate dimensions to adjust for differences in organismal size. Our results reveal associations between relative premolar size and diet that vary by clade and by independent size variable. Within catarrhines, premolar length and width are greatest in hard-object feeders when scaled against body mass but not when scaled against palate dimensions. Among platyrrhines, folivores tend to have relatively longer premolar rows than frugivores and, in some cases, hard-object feeders, whereas hard-object feeders tend to have wider premolars, but only when considered relative to palate size and not consistently so versus folivores. Although this mixed pattern of correlations is undoubtedly influenced by the use of simplistic dietary classifications, these results nevertheless point to a complex relationship between diet and premolar molarization.

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### The phylogenetic utility of mentum osseum morphology in Pleistocene *Homo*

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The chin, or mentum osseum, is considered a *Homo sapiens* autapomorphy and has long played a prominent role in the determination of systematic relationships in genus *Homo*. Despite extensive literature describing the anatomical traits comprising the anterior mandibular symphysis, the timing of their appearance throughout genus *Homo* evolution is still not fully understood, particularly given the incipient chins seen on some Neandertals (e.g., Zafarraya). This project assesses the taxonomic validity of the topographic traits comprising *H. sapiens* anterior mandibular morphology, testing whether five key features of the chin statistically significantly differentiate *H. sapiens* from two other taxa (*Homo heidelbergensis* and *Homo neanderthalensis*) in static adult comparisons. Surface scans were collected from a large sample of *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens*, and 3D coordinate (semi)landmark data were subjected to principal components analysis of Procrustes shape variables. Tukey's HSD test confirms that *H. sapiens* separate from both *H. neanderthalensis* and *H. heidelbergensis* along PC1; however, along PC2, *H. sapiens* and *H. neanderthalensis* group together, but separately from *H. heidelbergensis*. While warp grids for PC1 emphasize the topography of the chin itself, PC2 emphasizes the incurvatio mandibulae, highlighting differences that have been noted regarding the relative lack of topography on the *H. heidelbergensis* symphysis compared to both *H. sapiens* and some Neandertals. Given the importance of the chin in defining *H. sapiens*, this research, demonstrating overlap in overall anterior symphyseal shape between *H. sapiens* and Neandertals, raises questions about the distinctiveness of the human chin.

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### Cooking and sugar bioaccessibility from starch in human evolution

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Cooking is a distinctive human behavior and is hypothesized as a critical adaptation in human evolution. Benefits proposed for cooking include

immune benefits, reduced diet-induced thermogenesis associated with cooked foods, reduced chewing time and effort, and greater energy returns from cooked foods caused by greater sugar bioaccessibility. Understanding the magnitude of these potential benefits of cooking is necessary to model the likely intensity of selection pressure favoring cooking as a behavioral adaptation in human evolution. Here we compare the bioaccessibility of sugars for cooked and uncooked potatoes using a TIM-1 simulated upper gastrointestinal tract.

The TIM-1 is a validated *in vitro* model for the upper gastrointestinal tract designed to control the effects of individual variability in the digestive process. Cooked and raw potato meals of 100 grams were fed in triplicate to the TIM-1 system. High-performance liquid chromatography (HPLC) was used to determine the bioaccessible fraction of mono- and disaccharides over the course of TIM-1 trials. Results show that cooking potatoes increased total sugar bioaccessibility as well as the rate of sugar release. Bioaccessibility for glucose, fructose, sucrose and maltose was significantly greater for cooked potatoes in all cases ( $p < 0.05$ , two-way ANOVA). The rate of sugar release was also greater for all three of the cooked trials. Most significantly, the total bioaccessible fraction of sugars doubles with cooking compared to raw potatoes. Such a large effect suggests that selection pressure favoring cooking would have been potentially powerful.

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### Variation in body and limb proportions between Early and Archaic Americans and the prehistoric Jomon of Japan

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In this study, we explore variations in body and limb proportions of the Jomon hunter-gatherers (14,000–2,500 BP); Lagoa Santa, South American (9,000–7,000 BP); Windover, North American (6,000–5,000 BC); Indian Knoll, North American (5000–4000 BP); Santa Cruz Islanders, California (Late Prehistoric 1500–1100 AD); and historic Tierra del Fuego with 11 geographically diverse skeletal samples from Africa, Europe, Asia, Australia, and Americas.

Manly's permutation regression tests indicate that body proportions and body mass are significantly correlated with minimum and maximum temperatures, but not with latitude and longitude. Limb proportions were not

significantly correlated with these climatic variables. Principal components plots of body and limb proportions separate "climatic zones:" tropical, temperate, and arctic populations. The New World groups show diverse phenotypes. The principal component plots indicate that Jomon and Lagoa Santa show similar phenotypic proportions: relatively wider body and heat adapted limb proportions. Tierra del Fuego displays cold adapted body and limb proportions.

Body proportions of Jomon, Lagoa Santa, Santa Cruz, Windover, and Tierra del Fuego are similar. Interestingly, body and limb proportions of Lagoa Santa, Jomon, and archaic Americans are different compared to Australians. Our previous study show that Jomon exhibit close craniometric affinities with Lagoa Santa and archaic North Americans and distant craniometric affinities with Australians, contra to Neves et al. who suggest that Lagoa Santa is more closely related to Australians. These data suggest that the ancestors of Jomon were important in the peopling of the New World.

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### Commingled Remains, Dental Health, and Subsistence at the Smith Creek Site in Mississippi

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Human remains excavated in the 1960s by avocational archaeologists from the Smith Creek site (22WK511) in Mississippi, were recovered from an abandoned private museum in northern Louisiana in 2011. The Louisiana Department of Justice agreed to accession the skeletal material for inventory, analysis, and disposition pursuant to NAGPRA. Due to the lack of proper archaeological excavation, mishandling of the remains during excavation, and poor conservation of the remains, the material is commingled, fragmentary, and poorly preserved. Thus, while at one time discrete burials may have been identifiable, the remains now are akin to those from an ossuary. Nonetheless, a full bioarchaeological analysis of the remains was possible and included an assessment of MNI, pathology, epigenetics, and dental health.

The Smith Creek site appears to span the Coles Creek and Plaquemine periods (approximately A.D. 700–1400). Sites such as this provide health, subsistence, and cultural practice information to complement similar data from other sites in the Lower Mississippi Valley. Recent dental health data collected from sites in close proximity to Smith Creek illustrate

subsistence patterns that are atypical for other Late Woodland populations. While the condition of the remains is not ideal, analysis of caries, LEH, periodontal disease, and wear imparts valuable information that adds to knowledge of indigenous lifeways in the Lower Mississippi Valley. In particular, the Smith Creek dentition is consistent with contemporary Lower Mississippi Valley populations in that dental data suggest a delayed tradition of cultivating starchy plants, while instead relying on local plant varieties.

#### **Hominoid humeral trochlear morphology is unrelated to suspensory locomotion**

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Hominoid elbow morphology is typically described as having features that increase stability as adaptations for suspensory locomotion. These include relatively large trochleae with large keels: the humeroulnar joint is more stable than the humeroradial and larger keels are argued to resist loading from multiple directions during suspensory locomotion. However, given the diversity of reconstructed fossil hominoid locomotor behaviors, this assumption should be reassessed by examining a diverse sample of anthropoids.

Our data confirm that hominoids have large trochleae relative to body size, with a general positive allometric trend among anthropoids. Cercopithecoids have larger trochleae than ceboids, and hominoids have larger trochleae than both monkey subfamilies (all  $p < .05$ ). However, contrary to expectations based on known locomotor behavior, highly suspensory orangutans and spider monkeys have significantly smaller trochleae relative to body size compared to those of gorillas and cebines, respectively (both  $p < .05$ ).

Trochlear morphology appears lineage specific with little association with locomotor mode. All hominoids have trochleiform trochlea morphology, often with greater variation within a genus than between genera. Hominoids have relatively large keels, although with little difference between suspensory orangutans and more terrestrial gorillas. Cercopithecoids and ceboids have relatively cylindrical trochlear morphology. However, the largest medial keel is seen in the largest monkey, the baboon, and not in the highly suspensory spider monkey. This suggests that larger keels are simply related to body size, and not necessarily suspensory locomotion. Taken together, this suggests that body size and lineage legacies, not suspensory locomotion, have affected hominoid trochlear morphology.

#### **Improving gait generation in fossil primates using multigoal evolutionary robotics**

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Forward dynamic simulation techniques are important tools for reconstructing the locomotion of extinct animals. In these approaches a detailed musculoskeletal model is created and movements are generated by calculating the muscle-generated and external forces and solving the equations of motion for an articulated structure with an appropriate mass distribution. Current popular techniques often rely on optimisation goals such as maximising forward speed or minimising the energetic cost of transport as a way of choosing between the large number of possible muscle activation patterns. However whilst these single goal optimisation approaches work well for hypothesis driven investigation, the quality of the predicted kinematics is often disappointing particularly when more sophisticated 3D models are used. Here we demonstrate, using a high-biofidelity quadrupedal model of a chimpanzee and our newly developed markerless 3D motion capture technique, how the inclusion of multiple optimisation goals greatly improves the kinematic realism of forward dynamic simulations, and particularly how this affects the footfall sequences that the simulation chooses. This work supports the idea that gait choice in primates is unlikely to be dictated by a single biomechanical factor but is more likely to be the result of multiple constraints such as performance, economy, skeletal loading, and balance acting together.

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#### **Plastic and fantastic: postnatal developmental changes and the evolution of the human social brain**

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Numerous studies have emphasized the overwhelming developmental plasticity of the brain, demonstrating that proper postnatal neuronal development of sensory areas depends heavily on input from environmental stimuli. Similarly, the development of areas involved in social cognition relies on input from the social and cultural system in highly flexible patterns. Key differences in developmental trajectories of both cortical and subcortical areas observed in human and non-human primate brains likely underlie enhanced capacities for cultural acquisition and hierarchical social organization derived in primates' lineages, and magnified leading to uniquely human capacities for the acquisition of language and complex cultural

behavior and cognition. Here, we outline some of these key developmental differences between humans and non-human apes, and show how differences in development likely mediate the emergence of species-specific cognitive adaptations. Further, such differences between species can be complemented by comparative data from studies of aberrant neurological development, as in disorders that affect human social behavior and cognition. In such disorders, the developmental timing of typical cortical organization is affected, the distribution between excitatory and inhibitory neurons is disrupted, and the morphology of specific neuronal populations is altered, which may result from vulnerabilities associated with recent adaptive genomic changes underlying the human neurocognitive phenotype. We will discuss the use of neurological disorders as models for the evolution of the human brain, suggesting that some disorders, such as Williams syndrome and autism, may offer more clues to the study of the evolution of social cognition than others.

#### **Dikika cercopithecids and paleoenvironment**

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**ABSTRACT-** Fossil cercopithecids from the Dikika research area have been examined in this study to explore their taxonomic status and investigate their paleoenvironmental context. The specimens are derived from the radiometrically well dated (3.42 – 3.26 Ma) Sidi Hakoma Member of the Hadar Formation. Their taxonomic attribution was done based on comparative studies with other living and fossil Cercopithecidae. For this purpose both qualitative and quantitative approaches were employed. Result of these analyses show that all Dikika specimens examined here belong to *Theropithecus oswaldi darti*. Furthermore, faunal abundance and sedimentological data combined with previously documented environmental evidence indicate that *T. o. darti* at Dikika lived in an open environment (habitat) within the paleoenvironmental mosaic.

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#### **Mixed Species Associations in Guianan bearded sakis (*Chiropotes sagulatus*) in Guyana**

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Polyspecific or mixed-species associations occur in a diverse range of taxa, offering several benefits to the species involved, including increased foraging efficiency, decreased risk of predation, and increased ability for territorial defense. By forming mixed-species groups rather than increasing the size of monospecific groups, primates can maximize the benefits of large group sizes without increasing intragroup feeding competition. While several researchers have reported bearded sakis (genus *Chiropotes*) forming mixed-species associations, the frequency with which they form such associations, circumstances under which these associations form, and possible factors influencing their formation are almost completely unstudied. Here, I use data from a long-term study of *Chiropotes sagulatus* in Guyana to test the hypothesis that mixed species associations formed more frequently, and for a longer duration than would be expected based on chance encounters.

During the 12 month study period, associations between *Chiropotes* and *Sapajus* and/or *Saimiri* were frequent (17 of 41 days), lasted for up to 75% of daily activities, and appeared to be actively maintained by the species involved. While the frequency of association formation was not greater than expected by chance, the duration of association was. Time spent in association per day was significantly negatively correlated with mean daily subgroup size and bearded sakis alarm called significantly less often when in association. In addition, they spent significantly more time foraging for insects during associations. I suggest that mixed-species associations provide bearded sakis with both anti-predator and foraging benefits but are limited in frequency by the extremely large ranges of *Chiropotes*.

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#### **Mitochondrial lineages in Assyrian populations**

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Assyrians are a Neo-Aramaic-speaking people who, prior to the Genocide of 1914-1919, resided in a territory today divided between northern Iraq, southern Turkey, and northwestern Iran. Present-day Assyrians share their name with the people who established the north Mesopotamian state of Assyria in the second millennium BCE. Assyrians are one of three pre-Islamic ethno-religious groups to have survived the Islamization of Mesopotamia and the Levant in the seventh century. The ongoing religious persecution of Assyrians since the Sassanid Era, accompanied with their linguistic and cultural separation from neighboring communities, has

encouraged a tradition of endogamy among Assyrians. Therefore, Assyrian communities are believed to have experienced limited admixture since the third century CE. This is especially significant in the context of Mesopotamia, where mass migrations during the Islamic Era have substantially changed the demographics of this region. Very little is known about the population genetics of Assyrians and prior to this study, data on Assyrian maternal lineages was limited to 22 Iraqi Assyrians. In order to investigate Assyrian mitochondrial lineages, cheek swab samples were collected from 65 unrelated diasporic Assyrians residing in the United States. Our initial results show that all these individuals belong to eight different West Eurasian haplogroups. Considering that East Asian and sub-Saharan haplogroups, especially L1, are present in low frequencies in neighboring Iraqi and Iranian ethnic groups, their absence in the Assyrian community is particularly interesting. These results are consistent with historical and ethnographic evidence which suggest relative isolation of Assyrians as a native Mesopotamian population.

#### **Using variation in dental microwear textures as a proxy for dietary diversity in Cercopithecidae**

AMY E. SHAPIRO. School of Human Evolution and Social Change, Arizona State University, Institute of Human Origins, Arizona State University.

Dietary diversity, a measure of the number and evenness of food types incorporated into the diet, is an important component of species's ecology that often relates to the abundance and distribution of species. Additionally, dietary diversity has been cited in many hypotheses regarding the geographic distribution and evolutionary fate of fossil primates. However, in taxa such as primates with relatively generalized dental morphology and diets, a method for approximating dietary diversity in fossil species is lacking. Here I present data testing the hypothesis that species with greater variation in dental microwear textures have greater dietary diversity.

I collected dental microwear scans from Phase II molar facets of eight species of extant African monkeys (Cercopithecidae) with differing dietary diversity. Dietary diversity was calculated based on average annual food type consumption frequency at study sites of wild populations. The overall variation in microwear variables for each species was significantly correlated with the species's dietary diversity. Additionally, variation in the individual variables complexity (*Asfc*) and scale of maximum complexity (*Smc*) also distinguished groups that were consistent with differences in dietary diversity. Although some variation due to seasonal and geographic differences among individuals was present, this variation was small in comparison to the variation among species.

These results suggest that greater variation in microwear textures is correlated with greater dietary diversity in Cercopithecidae and that these methods can be used in fossil cercopithecids to compare dietary diversity among related taxa. I give an example using a small sample of fossil cercopithecids from hominin sites.

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#### **A preliminary analysis of the iliac trabecular architecture of *Rudapithecus hungaricus***

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It has been proposed from postcranial and semicircular canal morphology that *Rudapithecus hungaricus*, a Late Miocene hominoid from Rudabánya, Hungary, was an arboreal quadruped with significant adaptations to below branch suspension. A relatively complete left innominate of *Rudapithecus* was excavated in 2006, preserving the majority of the iliac blade, a partial superior pubic ramus, a large portion of ischium, and the acetabulum. It was scanned recently at the Max Planck Institute of Evolutionary Anthropology (Leipzig) using high-resolution X-ray computed tomography.

The scans were examined to determine the extent and quality of preserved trabecular architecture within the fossil, and a preliminary analysis of the lower iliac trabeculae was undertaken. The trabecular architecture of most of the iliac blade is not preserved, but the ischium contains trabeculae suitable for analysis. Within the lower ilium there is a small pocket of relatively well-preserved trabeculae. The trabecular morphology of this region is potentially significant, as lower iliac cross-sectional area has been shown to be an adaptation to locomotor loading, as well as being one of the few places in the pelvis where biomechanical predictions based on locomotor regimes have been upheld. The *Rudapithecus* trabecular bone appears to have a lower bone volume fraction (0.2145), an intermediate degree of anisotropy (3.4385), and a mean trabecular thickness (0.1852) that exceeds those of *Pan* and *Pongo*. These results are mostly consistent with proposed relationships between these trabecular measures and body size, but are based on a very small sample.

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### Inflammation and anthropometric indices during the pubertal transition: What do the commonly used markers mean?

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Puberty is a period of shifting energy priorities and changing body composition. This study explores the relationship between inflammation, as measured by C-reactive protein, and traditionally associated metrics such as waist-hip-ratio, BMI, and skin-folds in a population of Gambian female adolescents (n=67). Adipose tissue, particularly visceral adipose tissue, is proinflammatory, and BMI has evidenced a strong relationship with inflammation in adults and children in Western societies. This relationship is more complicated in non-Western societies, and very little work has examined how body composition metrics may relate to inflammation during puberty, especially in non-Western populations.

These adolescent females are lean (mean BMI = 20.5) and have relatively low CRP (median CRP = 0.11 mg/L, mean = 0.41 mg/L). Even among very lean participants, fat percent, WAZ, and BMI are all positively related to CRP, though BMI has the strongest relationship. Interestingly, there is an independent and negative association between triceps skinfolds and CRP - individuals with more adipose tissue stored in triceps have lower CRP levels. Unlike Western populations, waist-hip-ratio is not related to inflammation. These participants are still undergoing the pelvic maturation process of puberty, and WHR may not tie as strongly to visceral adiposity as in adults.

Our analyses show that this population has very low levels of CRP compared to Western populations and CRP relates to body composition in interesting ways. This is likely influenced by their pathogen and nutritional environment, as well as their life history stage, and these factors should be considered in inflammation research.

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### Necropolitics and Bioarchaeology: Enduring Legacies and Ethical Responsibilities

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An unfortunate aspect of the history of our discipline is early 'scientific' research pursuing the justification of racial typologies as a method for social and political discrimination. Though we have mostly moved beyond these paradigms, this legacy remains in both popular understandings of race and in the composition of many research collections, including the Terry and Morton collections. The bodies of politically disenfranchised minority groups predominantly compose these historical research collections, highlighting how early bio-political concepts of race in American history contributed to the pervasive maintenance of racial discrimination in modern socio-politics. An applicable example of this is the Michael Brown shooting and the ensuing public outrage of the immediate objectification of his corpse. How can the concept of "necropolitics" inform modern osteological research, and how can biological anthropology contribute to larger political discussion on body sovereignty and racism in modern America? We suggest that philosophical discourse on "becoming subject" has value both for our understanding of the history of our discipline and the responsibility biological anthropology has to inform the general public about "race" and our research subjects. Political programs like NAGPRA attempt to deconstruct this legacy; however, biological anthropology's ethical responsibilities to our field, the public, and these collections are larger than what is currently being addressed. We discuss the use of the necropolitical framework in future negotiations of the status of osteological collections, and potential contributions biological anthropology has to broader modern political discussions about race and the body after death.

### Integration of nervous system tissues into primate phylogenetics

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Soft-tissues have been classically underutilized in analyses of primate phylogeny and locomotor evolution despite being potentially character-rich segments of the vertebrate body. While studies using muscular characters have gained popularity in recent years, several other types of soft-tissue exhibit these same favorable characteristics and have not yet been thoroughly studied. Among which are structures of the peripheral nervous system that innervate the tetrapod limb, such as the brachial and the lumbosacral nerve plexuses. These structures are an additional resource with which to evaluate cases of locomotor homology and homoplasy in extant primates, and thereby test hypotheses about the evolution of locomotor types in extinct clades. Little is known of the particular morphological configurations of the

peripheral nervous system for non-human primate taxa, and even less is understood about the interaction and evolution of these segments in relation to muscular and skeletal changes. To test hypotheses related to phylogenetic significance and the relationship with locomotor categories, primary dissection of the brachial and lumbosacral plexuses was conducted for 12 taxa including four ape, four platyrrhine, and four cercopithecoidea genera. Parsimony analysis of 28 brachial plexus characters derived from root values and branching patterns recover phylogenetic signal mostly consistent with current molecular phylogenies for the primate taxa studied here, while parsimony analysis of 15 lumbosacral plexus characters indicate a primarily functional signal. These results suggest that while these structures contain some phylogenetic signal, they may also be useful in reconstructing ancestral locomotor profiles when integrated with bony and muscular data.

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### Testing the undersampled tarsier hypothesis

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Tarsiers are diverse phylogenetically and behaviorally. Owing to the very short branch between the diversification of Primates and that of Haplorhini, they are essentially a third, nearly-independent, radiation of primates with which to test hypotheses of primate evolution. It has been known for more than thirty years that tarsiers include both gregarious and solitary species. More recently it has been found that phylogenetic diversity within Tarsiidae is approximately as great, or greater, than that within Hominoidea. Nevertheless, studies of primate phylogenetics, molecular evolution, and social evolution continue to employ what we call the undersampled tarsier hypothesis. Briefly, this is an implicit hypothesis within primatology that tarsiers need not be sampled as densely as other primate taxa of similar phylogenetic age. We examine several recent studies, highlight their use of the undersampled tarsier hypothesis, and assess the impact of the alternative hypothesis where feasible. We find that when tarsiers are sampled as densely as are other primate taxa, the conclusions sometimes conflict with those in the original study. Through our work we hypothesize that stem tarsiers were gregarious and lived in small social groups. We re-examine some key features of primate evolution within this framework.

### Basketmakers revealed: Physical, CT, and 3D analyses of mummified human remains from the southwest

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The Basketmakers were groups of sedentary agriculturists in the American Southwest dating from 1500 B.C. to A.D. 500. They were the basket-making antecedents to the Ancestral Puebloans (formally known as the Anasazi), who are well known for their pottery and cliff dwellings at places like Mesa Verde. Less is known about the Basketmaker populations. Previous research has focused on their basketry, pottery, diet, and agriculture, but few studies have addressed their skeletal biology.

In 2014, a team of Smithsonian scientists spent a week at the Penn Museum examining the remains of eight previously unstudied Basketmaker mummies from the Grand Gulch region of Utah through physical analysis, photo documentation, and archival research. The hot, dry environment of the southwest desiccated and naturally preserved the tissues of these mummies. Internal organs, bones, teeth, and anomalies that are used to develop a biological profile composed of (but not limited to) age, sex, health, pathology, and cause of death are concealed.

Computed Tomography (CT) technology allows non-invasive analysis of mummified remains and was critical for the collection of biological data. CT scans were obtained from the Open Research Scan Archive at Penn. 3D models of the remains were created using the Mimics Innovation Suite. Featured are two case studies of three mummified individuals from the Penn Museum that were analyzed using gross observation, CT, and 3D modeling. Our study demonstrates how physical examination and CT scan data can be utilized to conduct initial examination, refine archival records, and guide more in-depth future analyses.

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### Proliferation Response to Ethanol: *Porphyromonas gingivalis*

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Oral pathogens likely contribute to atherosclerosis-related inflammation by infiltrating a host's immune system and contributing to foam cell development within arterial walls. Individuals diagnosed with periodontitis possess an increased risk to develop atherosclerosis. Nucleic acids from oral microbes have been detected in atherosclerotic plaques using PCR techniques, and one group claims to have cultured viable pathogens from an atherosclerotic plaque sample. *Porphyromonas gingivalis* is a Gram-negative periodontal pathogen able to systemically infect a host via transient bacteremia or invasion of PBMCs. Experimental *in vitro* evidence indicates that *P. gingivalis* increases the rate at which PBMCs transform into cholesterol-laden foam cells. Foam cell formation represents the earliest pathological sign for atherosclerosis development. Moderate alcohol consumption reduces the risk for developing atherosclerosis, as does proper oral hygiene. Ethanol is primarily metabolized in the liver by alcohol dehydrogenase into acetaldehyde; although, some ethanol enters the blood. If oral pathogens manage to systemically infect a host via bacteremia or infecting PBMCs, ethanol in the blood may act as a bactericidal agent to reduce foam cell formation and subsequent atherosclerotic progression. This hypothesis was tested using planktonic *P. gingivalis* cultures incubated with serial dilutions of ethanol. Proliferation responses were inhibited by the presence of ethanol. All experimental ethanol concentrations exhibited significant inhibition at 4- and 6-hours when compared to a negative control. These results indicate the inhibitory nature of ethanol to planktonic *P. gingivalis*, even at low concentrations. Thus, human populations that consume alcohol should hypothetically experience less atherosclerosis than populations abstaining from alcohol consumption.

### Functional scaling trends in the trabecular architecture of the mandibular condyle of Strepsirrhine primates

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The functional morphology of the primate mandible maintains considerable interest from the anthropological community. Jaw morphology has been linked to diet and feeding behavior and used to infer dietary adaptations and feeding behavior in extinct primates. While external jaw form has received significant attention, the internal morphology of the mandible is still being systematically evaluated across primates. Thus, it is not surprising that the structural variation of the trabeculae inside the mandibular condyle remains largely unknown across

primates. We investigate strepsirrhine trabecular architecture to assess size-related variation of trabecular features across this clade as a baseline for understanding the functional significance of variation in trabecular form.

We examined  $\mu$ CT images of mandibular condyles of 102 adults from 30 strepsirrhine species ranging in size from mouse lemurs to indri. The entire condylar trabecular volume was processed in Avizo 8.0 as a VOI and imported into BoneJ for estimation of trabecular morphometric parameters. Phylogenetic comparative methods were applied to address issues of phylogenetic non-independence.

PGLS regression indicates that trabecular thickness (0.47) and spacing (0.49) scale with negative allometry relative to mandible length as a functionally-relevant mechanical standard. Independent contrasts suggest that Connectivity density, estimating connections per bone volume, and the degree of Anisotropy do not change significantly with jaw size across strepsirrhines. Alternatively, the Structure Model Index (SMI) decreases with size suggesting larger animals exhibit more plate-like trabeculae. Future work will link these size-related trends in trabecular architecture to variation in diet and feeding behavior across Strepsirrhines.

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### Determination of ancestry from the skeleton: The application of nine existing methods produces inconsistent results

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Although the concept of race has been thoroughly criticised in biological anthropology, forensic anthropology still uses methods to determine the 'race' of a skeleton. The methods must be evaluated to see how effective they are given large individual variation. This study used 20 cases of skeletons of varied provenance to test whether nine published methods of 'race' determination, which use a range of various approaches (e.g. Gill 1984, Bass 1995, Patriquin 2002), were able to consistently identify their ethnic origin. No one individual was identified as belonging to just one 'major racial class', e.g. European. In 14 cases (70%), various methods identified the same individual as belonging to all three racial classes. Results of various methods did not correlate (Spearman) with each other, while they provided significantly different results (Kruskal-Wallis test). The methods are limited by the geographic population from which their discriminant functions or morphological traits were derived. Methods of multivariate linear discriminant analysis, e.g. CRANID, are supposed to allocate a skull to a specific



population rather than a 'race', however, in our analysis CRANID produced ambiguous allocations of skulls to specific populations. Great caution must be taken when attempting to ascertain the 'race' of a skeleton, as the outcome is not only dependent on which skeletal sites are available for assessment, but also on the degree to which the unknown skeleton's population of origin has been investigated. The very concept of 'race' is inapplicable to variation that occurs mostly inside populations and only in small ways between them.

**Microsyopids from the Early Eocene of the Southern Bighorn Basin, Wyoming: evolutionary insights from the largest stratigraphically controlled sample of stem primates**

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Microsyopidae is a long-lived group of early Cenozoic stem primates, known from a sample of more than 1500 stratigraphically controlled dental and gnathic specimens from the Early Eocene of the Southern Bighorn Basin. This sample allows for unprecedented consideration of the fine-scale evolution of a stem primate group. In particular, several transitions can be tied to previously documented climatic events, including the replacement of *Arctodontomys wilsoni* by the larger *A. nuptus*, which can be linked to marked localized cooling, and the appearance higher in the section of the tiny *Microsyops cardiorestes* during a period of localized warming. Reduction in body mass of *M. angustidens* (as inferred from smaller tooth size), and its ultimate replacement by *M. latidens*, may relate to a global hyperthermal event (ETM2). These reductions in body mass with warming parallel previously documented body size change in many lineages in the earlier PETM hyperthermal.

The density of this sample also allows for inferences to be made about evolutionary process. In particular, intermediate specimens document evolution of *A. nuptus* into *M. angustidens*. Interestingly, *A. nuptus* re-occurs after a 60+ m absence from the record, implying that this must have been a cladogenetic speciation event, with *M. angustidens* branching off from *A. nuptus*, but the latter species persisting.

In sum, the very densely sampled record of microsyopine microsyopids from the southern Bighorn Basin allows for fine-scaled documentation of evolutionary transitions, some of which appear closely tied to environmental

change, and allows for a rare direct documentation of cladogenetic speciation.

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**Genetic variants and alcohol intake patterns in university population in Santiago of Chile**

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Genetic variants involved in inefficient (*ADH1B2\*2* y *ALDH2\*2*) or efficient (SNP6 rs1800759, *ADH4* gene) alcohol metabolism have been associated with degrees of susceptibility to alcoholism in individuals. Alcoholism susceptibility has been classified into two phenotypes: "protector phenotypes" and "risk-dependence phenotypes", associated with inefficient and efficient alcohol genetic metabolizing variants, respectively.

Here we investigate the possible relation between genetic protective and risk-dependence variants and alcohol intake patterns according to AUDIT questionnaire designed by WHO. DNA saliva samples and data of the AUDIT questionnaire were obtained (prior approval of the ethics committee) from a sample of 210 individuals from Universidad de Chile between 18 and 25 years old.

As results, it was not possible to establish a statistic relation between protective or risk-dependence genetic variants and alcohol pattern intake. However, instead we found a higher frequency in alcohol risk-dependence allele (ji-square test = 10.33; df=2; p-value = 0.005) and risk-dependence phenotype (ji-square test= 4.33; df=1; p-value= 0.03) for *ADH4* rs1800759 marker compared to those reported in other regions of America by 1000Genomes project.

These findings suggest that Chile would present an increased risk of alcohol dependence given by this genetic factor; data that is more relevant in individuals with alcohol consumption patterns classified as harmful or dependent. In addition, new categories of alcohol consumption (not included in the AUDIT) were identified. Finally, the lack of association between consumption patterns and genotypes for these loci is discussed.

**Local Populations, Bioanthropological Research and the Promotion of Public Health in Amazonia**

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The implementation of public health policies in the Brazilian Amazon is a major challenge due to the complex geographic, environmental, economic, and cultural characteristics of the region and its populations. Adding to this challenge is the fact that there is limited data about the health situation of most of the rural Amazonian groups, especially Caboclos, Ribeirinhos and Quilombolas. Bioanthropological studies of such groups are valuable to help identify their health and socioecological characteristics and to empower them. However, many researchers in our field find it difficult to create mechanisms to engage the local populations and disseminate research findings in an accessible and applicable manner. Over the past two decades, our group has developed experiences of empowering communities where research has taken place through involvement of local leaders and youth in participatory research, workshops with traditional health practitioners, "brainstorm" meetings with community chiefs, and by gender and age groups, with local and State agents, and public audiences moderated by researchers. These initiatives have helped to promote common understanding of health rights, the implementation of policies in more adequate ways to the specific needs of each group or community, and also opened opportunities for new research. Bioanthropological data bring a strong sense of reliability and impartiality to the discussion table between health officials and the communities. Our results show that researchers properly trained can help to translate complex biomedical information to both rural communities and local officials, and jointly aid in the development of practical actions to address communities' health issues.

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**Comparing methods of assessing cranial ontogeny in a known-age sample of *Macaca mulatta***

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Recent geometric morphometric studies have used different approaches for assessing cranial ontogeny in primates. We aim to determine 1) how different are ontogenetic trajectories produced with different ontogenetic surrogates? and 2) which ontogenetic surrogate most accurately tracks ontogenetic shape change in the cranium?

Forty three 3D landmarks were digitized with a Microscribe 3DX from an ontogenetic series (M0: 16M/14F; M1: 18M/29F; M2: 25M/19F; M3: 20M/19F) of *Macaca mulatta* crania from the Caribbean Primate Research Center, Puerto Rico, with associated ages at death. Ontogenetic trajectories of cranial shape change were computed by sex through multivariate regression

of Procrustes aligned coordinates against three surrogates for ontogeny: natural log of centroid size (growth), molar eruption stage (development), and chronological age. These trajectories were compared by calculating the angles (dot products) between each surrogate's vector by sex. Each trajectory was then used to produce simulated adults from all M0 juveniles, which were then compared with actual adults. Differences between simulated and actual adults were quantified by Procrustes distance between the mean simulation and mean adult configurations.

All three ontogenetic surrogates produced similar vector angles (Males: size vs. developmental stage: 2.7°; size vs. age: 5.8°; developmental stage vs. age: 6.8°; Females: size vs. developmental stage: 3.9°; size vs. age: 7.9°; developmental stage vs. age: 8.5°), but size and developmental stage were most similar. When comparing simulated and actual adults, molar eruption stage produced the smallest Procrustes distances (M=0.005; F=0.012), size produced the second smallest distances (M=0.012; F=0.015), while chronological age produced the largest (M=0.05; F=0.049).

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#### **Immunogenetic regulatory variation associated with parasite infection in the Ugandan red colobus**

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Primates have co-evolved with their pathogens, and this is evident in immune processes. While research in this area has primarily focused on protein-coding regions of the genome, the role of regulatory genetic variation in controlling an organism's immune response to infection remains largely unstudied. We tested associations between the core promoters of two immune-related genes and gastro-intestinal helminth infection intensity in the Ugandan red colobus at Kibale National Park, Uganda. Our two candidate genes were IL-4 and MHC-DQA1, both of which have known associations with gastro-intestinal helminth infection, and we focused on the whipworm parasite (*Trichuris*), which has known fitness consequences in humans. We sequenced core promoters of both genes in 31 Ugandan red colobus and reconstructed individual haplotypes. While the

core promoter of IL-4 contained no variation, fifteen individual regulatory variants were identified in the functionally important transcription factor binding sites of the MHC-DQA1 core promoter. Genotypes for each SNP were tested for associations with shedding of whipworm (*Trichuris* sp) eggs in feces using a generalized linear model. Our results identified two functional regulatory variants associated with increased shedding for the heterozygote genotype (SNP-121,  $p = 0.007$ , and SNP-197,  $p = 0.012$ ). This pattern of heterozygote disadvantage is consistent with allelic expression imbalance, whereby differential expression of alleles in heterozygotes is associated with a deleterious disease phenotype. This work highlights the importance of regulatory genetic variation in determining disease susceptibility in primates, as well as the underlying role of gene expression in explaining variation in parasite shedding intensity.

#### **Cranial sexual dimorphism in *Papio hamadryas kindae*: same or kinda different?**

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The smallest extant member of genus *Papio*, the kinda baboon is distinguished by slender build, low sexual dimorphism, and moderate facial prognathism. Ontogenetic scaling accounts for most cranial-shape differences between subspecies and sexes within *Papio*, but there is evidence that the kinda follows a separate ontogenetic trajectory. If so, it may differ in patterning as well as magnitude of cranial dimorphism. To evaluate this hypothesis, 3D geometric morphometrics was used to investigate patterns of cranial sexual dimorphism in *Papio*. Data comprising 34 craniofacial landmarks collected on adults of *Papio* subspecies were obtained from the NYCEP PRIMO database. Sexual dimorphism was quantified using Procrustes distances and centroid size. Patterns of sex- and size-related variation were explored using MAN(C)OVA, angular comparison of multivariate regression vectors, and form-space PCA.

Kinda size and shape dimorphism are both significantly lower than in other subspecies ( $p < 0.001$ ). Scaled to size dimorphism, the relative magnitude of kinda shape dimorphism is similar to yellow and chacma baboons ( $p = 0.78$ ). Patterns of adult allometry and sexual dimorphism differ significantly among subspecies ( $p < 0.001$ ), and their corresponding vector-angle matrices are strongly correlated ( $r = 0.97$ ,  $p = 0.002$ ). The kinda's allometric vector is most similar to that of the chacma baboon but significantly different from all subspecies ( $p < 0.003$ ); however, few dimorphism-vector

comparisons achieve significance. Form-space PC3, which summarizes size-independent sexual shape dimorphism, separates the kinda from other subspecies ( $p < 0.003$ ). Differences in kinda craniofacial dimorphism patterns will be related to hypotheses concerning sexual selection and trait polarity in *Papio*.

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#### **No longer the 1%: Optimizing ancient DNA yield from Saharan African samples**

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Ancient DNA analysis confronts unique challenges associated with extracting and sequencing depurinated biomolecules often less than 100 base pairs in length while simultaneously battling modern DNA contamination. Additional challenges arise during analysis of samples from hot and arid environments that have been subject to oxidative thermal damage that inhibits extraction and amplification of DNA molecules. Presently, no positive aDNA results have been published from these extreme regions, such as Saharan Africa.

Particularly for samples from hot and arid areas, utilization of aDNA protocols that have been optimized to increase recovery of fragments of short length is necessary. In dedicated aDNA facilities at University College Dublin, we successfully sequenced several specimens from Kulubnarti, Sudanese Nubia dated to the Early Christian era (500-1400 AD). Petrous bones, which demonstrate superior DNA preservation, were used for this analysis. Powder aliquots were extracted using Dabney et al.'s (2013) optimized extraction protocol. After indexed library preparation, sequencing took place on Illumina's next-generation sequencing (NGS) platform, with yields up to 22.7% endogenous aDNA attained from the petrous material. Quality-control analysis indicated authenticity of the DNA and principle component analysis based on single nucleotide polymorphisms placed the individual around Middle Eastern and Central/South Asian clusters.

This study demonstrates a major step forward in our ability to obtain positive results using ancient specimens from arid regions through optimized extraction protocol and NGS technology. With the door to Saharan aDNA analysis opened, we have the opportunity to improve our understanding of gene flow and admixture throughout Saharan Africa.

**The “Shear Resistance-Priority Hypothesis”:  
A Means for Enhancing Understanding of  
Material Adaptations in Bones that  
Habitually Experience Complex Loading**

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In anthropological studies of cortical bone adaptation in limb-bone diaphyses there is an unrecognized bias — the bones examined are often habitually/stereotypically subjected to complex loading. Consequently, bone matrix adaptations can be difficult to interpret because complex loading engenders prevalent/predominant shear strains. Of the three strain modes (shear, tension, and compression) shear is potentially most deleterious (bone is strongest and more resilient in compression). Non-uniform strain distributions in cortical bone, whether produced by bending or combined bending/torsion, are an essential consequence of a bone’s function because they are linked to predictability of load and nutrient delivery. One solution for the regional prevalence/predominance of tension and compression in generally exclusive regions in habitually bent bones is the formation of strain-mode-specific osteon morphotypes and/or predominant collagen fiber orientation (CFO). If, however, a bone is loaded primarily in torsion, then clear regional variations in histomorphological adaptations for these ‘conventional’ strain modes do not occur. This is because in limb-bone diaphysis loaded in habitual torsion there are no significant regional disparities in strain modes. The prevalent/predominant mode in torsion is shear; by the adult stage, the adaptation for this mode might be seen as relative greater uniformity in matrix organization when compared to bones that experience habitual bending with little torsion (e.g., CFO is relatively more uniform across the entire bone cross-section). Because this is not intuitive, we recommend considering the “shear resistance-priority hypothesis”, which helps in understanding how a bone might adapt at the material level when the strain milieu has prevalent/predominant shear.

**Ancient wolf genome reveals gene flow with  
domestic dogs**

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The origins of dog domestication and the extent of gene flow with local wolf populations remains highly contentious, despite dogs being the first

domesticate and of high economical and cultural importance to ancient and present-day human societies. We sequenced the genome of a Pleistocene northern Siberian wolf to an average 1-fold genomic coverage in order to study its relationship to modern-day wolf and dog populations. The ancient wolf show evidence of shared ancestry with modern-day wolf populations, thus providing evidence that at least some of the structure between wolves and dogs dates back to the Pleistocene. We also show that genes from the ancient Siberian wolf introgressed into Northeast Siberian dog breeds after their divergence from European breeds, which sheds light on human migrations into the New World Arctic.

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**Assessing the Role of Migration in Cahokia’s  
Population using Strontium Isotope Analysis**

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This vast cultural center of Cahokia arose quickly, with a dramatic population increase relative to the preceding Late Woodland. Population estimates for Cahokia are as high as 20,000 individuals, a number that cannot be accounted for by in-situ birth rates or the consolidation of local settlements prior to Cahokia’s formation. This growth necessitates an influx of “new” people to the region.

Strontium isotope analysis of archaeological, small, and non-migratory mammal teeth from the American Bottom of Illinois refined the local strontium signature for the Cahokia region (Slater et al., *J. Arch. Sci.* 2014). Analysis of human teeth from multiple mound and cemetery contexts at Cahokia were compared to this range and about one-third of individuals sampled had ‘non-local’ strontium isotope ratios, indicating that they had migrated to the area.

This poster presents results of new strontium isotope analyses carried out to identify where Cahokia’s migrants were coming from. Modern mussel shell from the Illinois and Mississippi Rivers, as well as micro-mammal teeth from archaeological sites in Illinois and other locations within Cahokia’s interaction sphere, were analyzed to better characterize the isotopic variation in these possible population source areas. Results suggest that migrants may have come from areas in the Illinois River Valley and Wisconsin, though some individuals have strontium ratios that fall outside these ranges and must have come from elsewhere. Ultimately, these results indicate that migrants came from multiple different regions and likely shared few personal bonds, necessitating the development of

novel religious, social, and political systems at Cahokia.

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**Primate community evolution in the southern  
African Plio-Pleistocene: Dietary overlap and  
niche differentiation of fossil cercopithecoids**

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Fossil cercopithecoids are well represented in Plio-Pleistocene cave deposits of southern Africa. The rich taxonomic diversity of these primate communities is unparalleled in the region today, and warrants further study into the ecology of these fossil taxa. This project examines changes in the dietary ecologies of fossil primate communities using multiple proxies for diet collected from the literature. Dental microwear, stable carbon isotope values, shearing crest lengths, and mandibular P<sub>4</sub>-M<sub>3</sub> lengths were analyzed in multivariate space to look for patterns of niche differentiation among these taxa. In addition, this project looks at whether and how individuals may have altered their dietary ecology when faced with extinction risk posed by changes in resource availability.

Results suggest that fossil representatives of *Parapapio* and *Papio* occupied a generalist dietary niche, while species of *Theropithecus*, *Cercopithecoides*, and *Dinopithecus* are reconstructed as more specialized. Additionally, changes in primate diets between Makapansgat Members 3 and 4 and Swartkrans Member 1 appear to correspond to changes in southern African Plio-Pleistocene environments that indicate that younger sites are characterized by increasing aridity and reduced woodland habitats. However, the primate community at Sterkfontein Member 4 is suggestive of a more homogenous habitat that supported a less diverse primate community than was present at sites such as Makapansgat and Swartkrans. Focusing future research on multivariate approaches to fossil primate ecology will allow a better understanding of dietary variation within and across populations of species living in diverse habitats.

**Plasticity of Human Lumbar Vertebrae as a  
Tool for Interpreting Age, Sex, and Life  
History**

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Unlike in many other animal species, the spinal column in humans is a weight-bearing structure due to obligate bipedal locomotive behavior, and



thus the spinal column exhibits distinctive remodeling patterns with aging. Since the spinal column is a weight-bearing structure, sexual dimorphism in human body mass and morphology should influence the degenerative process of the vertebrae. Consequently, vertebral centrum dimensions may be useful for estimation of skeletal sex. The purpose of this study is to investigate sexual dimorphism of the lumbar vertebrae by analyzing vertebral dimensions of 60 individuals of known age and sex. Aging-related morphological changes in centrum shape are also analyzed to assess sex-based differences in vertebral aging. Five dimensions of each lumbar vertebra are gathered from the William M. Bass Skeletal Collection at the University of Tennessee. ANOVA, T-tests, PCA, and linear regression tests using SPSS statistical software were used to assess shape differences between sexes and age groups. Results from this study indicate that females exhibit a significant relationship between age and vertebral centrum height ( $p = 0.000$ ), particularly with regards to the L3 vertebra ( $p = 0.031$ ), which may be related to lumbar lordosis during pregnancy. Males do not exhibit a relationship between vertebral metrics compared to females. Sex- and age-based variation in vertebral morphology is an example of human plasticity and our unique evolutionary trajectory.

**A multi-tiered comparison of craniometric and molecular distances: A test case using specimens from the Norris Farms #36 archeological cemetery site**

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Bioarchaeological studies of past human population history often rely on fragmentary cranial elements or portions of the mitochondrial genome to estimate biological or genetic distances, respectively, because complete crania and extensive molecular material are often unavailable. Here, we conduct a multi-tiered (global and local) investigation of the relationship between cranial morphology and molecular data, with the goal of advancing bioarchaeological inquiry via an enhanced understanding of the ways in which these data sets co-reveal population relationships at increasingly localized levels, including the intracemetery level.

We estimated biological and molecular distances using matched individuals from the Norris Farms #36 archaeological cemetery site (AD 1300) using Howells' measurements, 3D morphology, and mitochondrial HVI. The same landmarks were digitized in global population samples and compared to interpopulation molecular distances

using Mantel tests. At the population-level, complete mtgenome-based distances were significantly associated with morphological distances of the cranium and upper face. Reduced molecular datasets, (mtDNA HVI, HVII-III, control region) and autosomal STRs all significantly correlated with cranial morphology, and HVI with neurocranial morphology. At the inter-individual level, Norris Farms HVI distances correlated with neurocranial Howells' dimensions, and marginally with 3D morphology of the entire cranium.

These findings suggest that the necessarily fragmentary data sources often used in intracemetery distance analyses have the potential to be used as proxies for more complete biological datasets, such the entire mtgenome or complete, unbroken crania. However, the more fragmentary the crania become, the more tenuous the relationship, suggesting that caution should be taken with especially poorly-preserved specimens

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**How do social dynamics influence gestural communication in *Pan*?**

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Bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*) display diverse social dynamics, but it is unclear how their varying social structures and relationships influence gestural communication. This study examines patterns of signaling within dyads to determine how social dynamics shape gestural signaling in *Pan*. A total of 336 hours of ad libitum video of social interactions were collected from bonobos at the San Diego Zoo (SDZ) and San Diego Zoo Safari Park (SDZSP), and from chimpanzees at the Saint Louis Zoo (STLZ) and Los Angeles Zoo (LAZ). From the video footage, we coded gestures, social contexts during gesture use, and the recipient's identity and response. All groups used between 27 and 33 distinct gestures, but there was inter-group variation in the rate of gestural signaling (SDZ=15.6 gestures/hour, SDZSP 36.1 gestures/hour; STLZ=14.5 gestures/hour, LAZ=6.8 gestures/hour). Among bonobos, adult females gestured almost equally to females and males of all ages, demonstrating their more egalitarian, female-dominant social structure. Among chimpanzees, adult females at STLZ gestured significantly more to other adult females (92.0%), while adult females at LAZ gestured significantly more to juvenile males (62.8%). This inter-group variation is likely due to differences in group composition and affiliation among females. Adult males of both species gestured significantly more to group

females than any other age/sex class. Results suggest that aspects of each species' distinctive social dynamics are reflected in their patterns of gestural signaling. However, findings also indicate that gestural communication is flexible and highly dependent on group composition and group-level social dynamics.

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**Temporal change in the prevalence and pattern of periostosis in Woodland Period northern Illinois**

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After ~AD 600, technological innovations, increasing population density, and sedentism apparently altered the subsistence/settlement pattern within the Woodland Period in the upper Mississippi River Valley (UMRV) of Illinois. There is little available bioarchaeological information regarding community health within or over time in this region. The adults from two UMRV mortuary sites were examined for the pattern and prevalence of periosteal reactive changes: Middle Woodland (500 BC-AD 350) Albany Mounds (11WT1, N=65) and early Late Woodland (AD 600-900) Kuhlman Mounds (11A163, N=85). These were compared to the later Late Woodland (AD 850-1150) Schroeder Mounds sample (11He177, N=53). The raw frequency of non-specific periostosis is not statistically significant over time: 35.4% (23/65) in Albany, 27% (23/85) in Kuhlman, and 34% (18/53) in Schroeder Mounds. However, there is a temporal change in the presence and pattern of osseous reactive change specific to treponemal disease. The highest frequency occurs in the later Late Woodland Schroeder Mounds sample (7-8/53, 13.2-15%). It is the only site with pathognomonic cases (e.g., stellate cranial lesions, caries sicca) (4/7-8). Reactive changes indicative of treponemal disease (sabre tibia) occurred at all three sites and is the primary presenting reactive change in the Albany (3/65, 4.6%) and Kuhlman (9/85, 10.6%) samples. The Fisher's Exact Test calculated p value of the difference in treponemal disease prevalence between Albany and Schroeder is 0.0515. Temporal increases in the diagnostic visibility of treponemal disease are apparent and provide an important first step to understanding the broader subsistence/settlement dynamics in the UMRV of Illinois.

### Dental Perspectives on Weaning in Living and Fossil Primates

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Evolutionary anthropologists are increasingly employing knowledge of isotopic chemistry and tooth development to infer the evolution of human weaning. Recent studies of trace elements and incremental growth lines accurately document diet transitions including birth, exclusive nursing, solid food supplementation, and the cessation of suckling. Others have interpreted developmental defects in tooth crowns (accentuated lines) or on tooth surfaces (hypoplasias) as evidence for nutritional distress during the weaning process. We document the timing of early-life diet transitions from incremental development and barium/calcium (Ba/Ca) trace element analyses in captive rhesus macaques, and compare this to colony management records and evidence of developmental defects. Elemental ratios reveal variation in the weaning process among individuals ranging from an abrupt cessation of mothers' milk at 166 days of age, to a relatively steady decline in Ba/Ca over approximately 300 days in another individual. The first case shows an associated hypoplasia, although it is difficult to distinguish impacts of the diet transition from an illness that led to hospitalization. Frequencies of accentuated lines in other individuals follow patterns of Ba/Ca ratios; individuals who experienced earlier weaning appear to have more accentuated lines from 90-180 days of age, while the individual weaned around 300 days of age had fewer accentuated lines. Analysis of a Neanderthal first molar shows a truncated weaning process, with a steep drop in Ba/Ca and a marked accentuated line at 1.2 years of age. Characterization of the weaning process in non-human primates and well-preserved fossils is now possible at a fine temporal scale.

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### Body size and proportions among four indigenous Siberian populations: Climatic and social factors

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Indigenous Siberians occupy an extreme environment that exposes them to chronic cold stress, pronounced seasonality, and low overall energy availability. Furthermore, political events in Russia over the past century have created enormous social challenges for native Siberians. Because Siberia remained closed to outside researchers for most of the 20<sup>th</sup> century, few studies examined how climatic and social factors affected body size and proportions until pioneering work led by Michael Crawford commenced in 1991. This research among indigenous Siberians continues and now includes work among four populations: Evenki, Ket, Buryat, and Yakut (Sakha). This poster has three objectives. First, it discusses the contributions of research by Crawford and colleagues on growth and nutritional status among Evenki reindeer herders, which provides valuable information on how social conditions in the aftermath of the fall of the Soviet Union influenced health and well-being. Second, it presents data on adult body composition for four indigenous Siberian populations (Evenki, Ket, Buryat, and Yakut) and considers how lifestyle and nutritional factors explain pronounced variation in prevalence of overweight and obesity between populations (e.g., from 1% in Evenki men and 10% in Evenki women to 13% in Yakut men and 21% in Yakut women). Finally, anthropometric data from the Yakut are presented to consider the conformity of body size and proportions to ecogeographical predictions; results demonstrate that relative sitting height among men (53.1±1.2%) and women (53.4±1.2%) is consistent with predictions for cold-adapted body proportions. This research highlights the importance of developmental environments and population adaptive history.

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### Burial Patterns of the Pre-Classic Maya at Colha, Belize

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The purpose of this research project is to use regional biodistance analysis to better understand burial patterns amongst a prehistoric population from the lowland Maya site of Colha, Belize. Regional biodistance analysis is a technique used by bioarchaeologists to better understand familial relationships between archaeological populations. This research will use intracemetery analysis, a type of regional biodistance analysis, to analyze occupation history and burial practices at Colha. In particular, nonmetric traits will be used to determine phenotypic variability. Most of the skeletal materials were found in Lots 110, 223 and Lot 107, which was a crypt, from Operation 2031. The individuals from Lots 110 and 223 may represent a family group because of their location underneath the floor of the same house. It is also possible that the crypt represents a form of ancestor veneration conducted by the same family. If this is the case, there should be low phenotypic variability between these different lots. This would be further evidence of continued occupation of the site by a family group. Thirty-three cranial nonmetric traits were gathered from 30 individuals to determine phenotypic variability. Fisher's Exact Test were used to analyze the traits. In all tests, results were statistically insignificant which indicates that there is high phenotypic similarity among the individuals from Colha Operation 2031.

### Growing up woolly: Infant riding and the ontogeny of forelimb and hindlimb musculature of Humboldt's woolly monkey (*Lagothrix lagotricha*)

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Like many mammals, primate infants are not locomotor independent from birth and rely extensively on infant carrying. Consequently, infant primates differ considerably in size, shape and body composition from adults. As they gain locomotor independence, infant forelimb and hindlimb muscle mass is redistributed to accommodate changing biomechanical demands. Humboldt's woolly monkey (*Lagothrix lagotricha*) is a generalized arboreal quadruped with rudimentary suspensory capabilities. Although ontogenetic changes in the appendicular musculature of *Macaca* have been described previously, little is known about the ontogenetic scaling of these muscles in platyrrhines.

Here we present new data describing ontogenetic changes in relative muscle mass (MM) distribution and relative physiological cross section area (PCSA) of the forelimb and hindlimb musculature of *Lagothrix lagotricha* (n=8 adults, n=2 infants). Although there is a general increase in both relative muscle mass and PCSA across both limbs, infants are characterized by higher than expected MM and PCSA values in muscle groups associated with the functional demands of infant riding (shoulder, elbow and hip flexion, forearm supination, hip adduction and digital grasping). For many of these muscle groups infant MM and PCSA values are comparable to or exceed those reported for adults. Digital grasping muscles, however, are characterized by increased PCSA values in the absence of increased MM values. This suggests that functional changes in *Lagothrix* appendicular musculature related to ontogenetic changes in biomechanical loading are not restricted to the simple redistribution of muscle mass but may also include increasing PCSA in the absences of any significant MM increase.

**Dominance rank and rank disparity predict female rhesus macaque social relationships even in the absence of kin networks**

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Strong social relationships can confer important benefits in primate societies, from increased reproductive success to longer lifespans. However, individuals do not form bonds indiscriminately. In female cercopithecine primates, two non-mutually exclusive hypotheses have been proposed to explain social partner preference. First, individuals should preferentially form bonds with their close kin, if available, to maximize the indirect genetic benefits of affiliative relationships. Second, individuals should preferentially form bonds with higher-ranking individuals in exchange for social tolerance. Teasing apart the relative importance of kinship and rank has been challenging, as they are often highly correlated. Here, we isolated the specific effects of rank in female rhesus macaques by analyzing grooming patterns in experimentally formed social groups (n = 26 groups) that did not contain close relatives, and in which dominance ranks were randomized. We found that grooming was inversely related to social tolerance: the amount a female groomed another female was negatively correlated with the amount of aggression she received from that female. Further, higher-ranking females were groomed more often than lower-ranking females, suggesting that higher-

ranking females were more attractive social partners. Lastly, females formed the strongest grooming relationships with females adjacent to them in rank, and this pattern was most marked for the highest-ranking females. Our findings indicate that rank position and rank disparity between partners influence social bond formation even in the absence of kin. Hence, although indirect genetic benefits are likely important to social bond formation in primate societies, similar patterns may arise even when kin are absent.

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**Leporids, landscapes, and the paleoenvironment: Stable isotope ratios of rabbit and hare bones reflect local environmental conditions at modern and archaeological sites**

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Environmental conditions have enabled and constrained the evolution and social development of humans since the origins of our species. This study investigates the utility of stable isotope analysis ( $\delta^{13}\text{C}_{\text{apatite}}$ ,  $\delta^{18}\text{O}_{\text{apatite}}$ ,  $\delta^{13}\text{C}_{\text{collagen}}$  and  $\delta^{15}\text{N}_{\text{collagen}}$ ) of leporid (rabbit and hare) bones to reconstruct past environmental landscapes. Leporids are among the most frequently found mammals in North American archaeological contexts and at many early hominin sites, including Laetoli and several Neanderthal sites. The relatively small home ranges and short lifespans of leporids, moreover, make them an ideal species to track temporal changes in local environments. Here we present the preliminary results of stable isotope analysis of 145 modern specimens representing multiple environmental zones from across the United States and Mexico. Strong correlations between environmental parameters (i.e., mean annual precipitation, grass coverage, and ecosystem type) and bone isotope values indicate the utility of using leporid bones in environmental research. These baseline data are compared with archaeological leporid isotope values (N=320) from four New World archaeological sites (Teotihuacan, La Quemada, La Ferrería, and Pueblo Grande) in different ecological regions. Our results demonstrate that isotope ratios of leporid bones faithfully predict environmental types and indicate their usefulness for studies seeking to reconstruct environmental conditions of ancient human settlements and early hominin sites.

**Questioning Disability: Physical Impairment, Disabled Identities and Deviant Burial in Late Roman Britain**

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Human skeletal remains provide a unique opportunity for assessing the social status of the disabled in past contexts, through both evidence for any osteologically-recognisable impairment that they may have possessed and through what their burial can tell us about their social status. This poster examines the relationship between physical impairment and disability (as a form of social status relating to impairment) through the burial record of Late Roman Britain (3<sup>rd</sup>-5<sup>th</sup> C. AD.). Physically-impaired individuals have been associated with a variety of types of 'deviant' burial, both in Romano-British contexts and elsewhere in the archaeological literature, as a sign of presumed social ostracisation from their communities that correlates with a concept of disability. Such assertions however have typically relied on individual case-studies. This poster demonstrates that when viewed comparatively through a burial sample of 3000 individuals (both impaired and non-impaired), it is difficult to recognise consistent practices of deviant burial for individuals with the same or similar types of impairments that would constitute a consistent recognition of disability as a cause for this treatment. It will be shown that rather than using impairment/disability as the sole factor through which to view deviant burials when they occur, we must carefully consider social factors in relation to the age and gender of the individual, and how their impairment may have been perceived by others in relation to life-course based expectations. This approach demonstrates a more nuanced way of examining impairment in the past that can inform current debates on disability.

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**New data on Late Upper Paleolithic upper limb cross-sectional geometry from Arene Candide: implications for Tardiglacial hunting practices**

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European Late Upper Paleolithic people display levels of bilateral asymmetry in humeral mechanical strength comparable to professional tennis players. This highly-characteristic trait has been associated with the use of throwing weapons to "kill at a distance", an activity that likely required extensive training that began at a young age. Previous studies have pooled European samples to increase sample size. This pooling may have masked regional behavioral



variation associated with the fragmentation of populations during the Tardiglacial period (ca. 16-10,000 BP). We collected new data on upper limb (humerus and ulna) bilateral asymmetry for torsional robusticity (via cross-sectional geometry) on four adult males (AC 2, 3, 4, 12) and one adolescent (13 y.o., AC 16) from Arene Candide (northwestern Italy). Results indicate that all adult individuals show high levels of mid-distal humeral bilateral asymmetry (40% to 110%). Ulnar asymmetry was less pronounced (50% in two individuals, 5% in the remaining two). Despite the expectations of an early onset of throwing behavior, the adolescent individual displayed low humeral (12%) and ulnar (16.5%) asymmetry. Conversely, an adult with congenital x-linked hypophosphatemic rickets displayed high humeral asymmetry (40%). The genetic disorder affecting this individual resulted in low stature, diffused enthesopathies, and bowing deformities, which likely affected his ability to perform high-mobility tasks. Yet, results are suggestive of highly-asymmetrical upper limb torsional loadings, which may indicate participation in throwing behavior. The study of functional adaptations of physically-impaired prehistoric individuals may contribute to the understanding of how they integrated into the subsistence practices of their group.

**Do longer limbs translate into a reduced cost of transport? A study of locomotor performance and gait in the Longshanks mouse**

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Primates must travel in order to acquire the resources necessary to support life. Traits that improve locomotor performance, for example by reducing the energetic cost of ranging, may lead to a larger net energy intake, and thus may be favored by natural selection. One such trait is limb length: Previous functional studies, mostly among species, have shown a negative relationship between limb length and the energetic cost of transport (COT). However, the potential confounding effects of intra- and interspecific variation in other anatomical and behavioral factors in these studies make this relationship less straightforward. We investigated this relationship in the Longshanks mouse, a unique line selectively bred for increased relative tibial length. The Longshanks mouse has on average 13% longer tibia relative to body mass compared to a random-bred control cohort. We tested the hypothesis that the Longshank mouse would have a lower COT, mediated in part by increased stride length. Longshanks (N=22) and control mice (N=23) ran on a metabolic treadmill at three different speeds while oxygen consumption was monitored. The same mice also ran on a treadmill for gait analysis, which provided gait parameters

including stride frequency and stride length. Results show that COT is reduced by ~8-10% in Longshanks vs control mice. In addition, Longshank mice had increased stride length (+7-9%) and lower stride frequency (-6-8%). These data confirm the relationship between limb length and locomotor performance within quadrupedal species, with implications for the evolution of limb length diversity in primates.

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**Are terrestrial siamangs left or right handed?**

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Recent studies have demonstrated strong hand preferences for complex bimanual tasks in a wide variety of non-human primates. When extracting peanut butter from a tube terrestrial primates show a consistent preference for the right hand whereas arboreal primates are consistently left-handed. It has been hypothesized that when terrestrial primates were released from having to use their right hands for balance or hanging, they shifted to right-handedness. To determine whether handedness is learned by arboreal animals as they forage and move in the trees during their developmental years, or whether it is an innate hard-wired instinct that has been selected for in arboreal species, we studied handedness in a family of captive and predominantly terrestrial siamangs (adult couple and their two offspring) at the El Paso zoo. The family of four were all born and raised in captivity. In the wild siamangs are exclusively arboreal and left-handed for a complex bimanual water dipping activity (Morino, 2011). If handedness is innate, then left-handedness should be expressed in the El Paso siamangs in spite of their terrestriality. Handedness data for five complex bimanual activities was recorded from videos and photographs of the El Paso siamangs taken from 2006-2014. We found that, like their wild relatives, the El Paso siamangs are left handed and their handedness was consistent through time. Handedness was not consistent in the juveniles, shifting from a slight right to slight left preference from year to year. We concluded that handedness is innate rather than learned.

**Environmental Variables Affecting Primate Species Richness in the Neotropics**

JACKSON P. SPRADLEY, BLYTHE A. WILLIAMS and RICHARD F. KAY. Evolutionary Anthropology, Duke University.

We examined the effects of altitude and climatic variables on platyrrhine primate species richness

for 248 localities in Central and South America with species richness ranging from zero to fifteen sympatric primate species. Altitude and climate variables (mean annual precipitation [MAP], precipitation of the wettest and driest months, mean annual temperature [MAT], temperature of coldest quarter, and seasonality in rainfall and temperature) were compiled using georeferencing software *QGIS*, on a 1 km-square grid from *WorldClim- Global Climate Data*. Species richness data was compiled from recent literature surveys supplemented by our own data. Within the tropical zone, primate richness increases with increased rainfall up to approximately 2500 mm of rainfall, beyond which it is asymptotic, or even slightly declines. Considering all variables in a Principal Components Analysis of tropical localities, factor-loadings show that richness is most strongly and positively associated with MAP and MAT whereas seasonality in temperature and rainfall and altitude are negatively associated with richness. Outside the tropics, species richness declines with increased latitude, following the same factors but with the added factor of temperature seasonality as a negative effect. Temperature seasonality appears to be the most significant factor limiting southerly primate distribution.

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**Biodistance analysis of US/Mexico migrants**

M. KATHERINE SPRADLEY. Anthropology, Texas State University.

Studies utilizing skeletal data with known population histories have the ability to elucidate patterns of population structure and inform studies of migration. Migration across the US/Mexico border results in many apprehensions and deaths that suggest several interesting patterns, namely that the two largest migrant corridors, Arizona and Texas, have migrant groups with different countries of origin. Most migrant apprehensions in Arizona are from Mexico as compared to Texas where most apprehensions are from Honduras, El Salvador, and Guatemala, followed by Mexico. The purpose of this presentation is to utilize biodistance analyses of Arizona and Texas migrant deaths to further inform studies of migration.

Thirty cranial landmarks were collected from Arizona migrants (n=145), Texas migrants (n=13), and Guatemalans (n=75) and subjected to a General Procrustes Analysis, followed by a canonical variates analysis to generate Mahalanobis distances. Guatemalans are included to represent another known migrant group. Results indicate that all groups are significantly different from one another and that the Texas migrants are the most differentiated

and the most heterogeneous group. While the smaller sample size of Texas migrants may influence the results, the different population structures in the source populations are viewed as contributing to the significant differences in biodistance, despite being from the same broad geographic region. The heritability of craniometric data are discernable despite the close geographic proximity of the different countries of origin. The results will be discussed within the broader context and usage of the term migration.

#### **Spatial structure in the distribution of feeding trees used by the Japanese macaques of Yakushima Island, Japan**

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Home range utilization may reflect multiscale spatio-temporal problems faced by primates. Many statistical methods are now available to researchers for analyzing the spatial structure of primate home range use in GIS software. We report results of spatial analyses on the locations of trees used by female Japanese macaques (*Macaca fuscata yakui*) in Yakushima, Japan. First, we applied a kernel density estimate on feeding locations. Second we applied Hot-Spot analysis and Moran's I spatial autocorrelation tests on the trees for number of days of tree use and time spent in trees. The kernel density estimate was largely consistent with the Hot-Spot analyses identifying clusters of trees used by monkeys. In addition, Moran's I spatial autocorrelation test found significant autocorrelation in the number of days of tree use. However, spatial autocorrelation was weak for time spent in trees, and statistical significance depended on one tree species. Removing that tree species resulted in no significant autocorrelation for time spent in trees within the home range as a whole for all remaining tree species or any one tree species. These results are partly due to differences in the statistical measures, but we also interpret the results to be due to the time-space budget of the monkeys. Multiple use trees may be located near places where monkeys carry out other activities, especially grooming, in addition to feeding. By contrast, monkeys can spend large amounts of time feeding in trees that they rarely visit distributed throughout the home range.

#### **Eigencoats: A new method for the quantification and comparison of intra- and interspecific lemur pelage variation**

AMANDA N. SPRIGGS and ADAM D. GORDON. Department of Anthropology, University at Albany – SUNY.

Primate pelage serves a signaling function among conspecifics and congeners for fitness

and species identity and also plays a role in camouflage. The forces responsible for the maintenance of primate pelage coloration are complex and not fully understood. Members of Lemuriformes are highly sympatric and possess brightly colored pelages with a variety of patterns, making them an excellent group to study to better understand selection pressures on pelage coloration. Here we introduce a new application of a method that has been used for human facial recognition software and recently extended to explore facial character displacement in photos of guenons (called "eigenfaces"). We modified this method to quantify variation in the entire pelage or coat among samples of lemurs (which we call "eigencoats"). Digital photographs of preserved primate skins were calibrated for color accuracy and then these photographs were transformed from four-channel images (red, green, blue, and transparency) of rows and columns into column vectors of pixel data. A principal component analysis was performed on the covariance matrix of these vectors, allowing for the quantification of variation among specimens and the identification of regions of maximum variation within coats for a sample of individuals. We illustrate this method with an exploration of coat variation in *Eulemur* and show that females of *Eulemur coronatus* and *Eulemur macaco* are more similar to each other than to the male members of their species. This study focuses specifically on the pelage coloration patterns of lemurs; however, there are numerous applications for this method.

#### **Body Mass Estimation from Knee Dimensions in Hominins**

NICOLE SQUYRES and CHRIS RUFF. Center for Functional Anatomy and Evolution, Johns Hopkins.

The estimation of living body mass from skeletal material is an important component of the study of early hominins and more recent human archaeological remains. Most previous studies have concentrated on weight-bearing elements of the lower limb, in particular the femoral head. This study used new body mass estimation equations derived from measurements of the knee in a modern sample of known body mass to estimate body mass in 11 fossil hominin specimens (including *Au. africanus*, *Au. afarensis*, and early *Homo*). The reference sample consisted of 110 living humans who participated in the Baltimore Longitudinal Study of Aging. ML breadth measurements were taken from AP radiographs of the knee, and regressed against recorded body weight to generate body mass estimation equations. Knee dimensions were generally found to be good predictors of body mass in the modern human sample, with median absolute percent prediction errors of 7 to 8% (comparable to similar equations derived from the femoral head). Taxon average estimated body masses were 46kg for *Au. afarensis*, 42kg for *Au. africanus*, and 55kg for early *Homo*. Estimates for early *Homo* were similar to those

generated previously from the femoral head. Estimates for australopiths, however, were larger than those generated from femoral head equations by an average of 8kg. This result supports the idea that relative loading of the femoral head may have differed between australopiths and *Homo*, perhaps due to subtle differences in gait.

#### **Female friendships in a 'non-female-bonded' cercopithecine: genetic correlates of sociality and female choice in hamadryas baboons**

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The hamadryas baboon (*Papio hamadryas hamadryas*) is often characterized as 'non-female-bonded,' in contrast to its 'female-bonded' relatives such as geladas, non-hamadryas baboons, and other cercopithecines. Hamadryas society, however, is driven by the behavior of 'leader males' of one-male units (OMUs), who herd females forcefully into these units and limit their social interactions with other females, including female relatives. When a leader male dies or disappears, several females may become available simultaneously and may not all be immediately taken over by other males. In this situation females may be able to express choice in unit membership. Here we use genetic and behavioral data from a long-term field study to describe the dyadic relatedness of females. We found female dispersal to be limited across bands and possibly clans, providing opportunities for the maintenance of female kin bonds following natal dispersal. Furthermore, for the observation years after 2007, females within OMUs were on average significantly more related than females across OMUs. This pattern may be the result of the dissolution of five OMUs in 2007 due to the disappearance/death of their leaders and subsequent transfers of females into units containing relatives. A tendency of females to maintain bonds with female kin when possible is interesting in light of the hamadryas 'non-female-bonded' apomorphic state in baboon phylogeny. This suggests that a motivation to maintain bonds with female relatives has not been lost during hamadryas evolutionary history and that females are able to circumvent the hamadryas male-dominated social organization to at least some degree.

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### Exploring childhood diet of survivors and non-survivors in prehistoric Tonga (c. 500 - 150 BP) using isotopic analyses

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Isotopic analyses of bone collagen allows researchers to explore diet within the past few years of an individual's life, while dentine collagen represents childhood diet. This study utilized isotopic analyses ( $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ ) from dentine and bone collagen in adults and collagen from cortical bone in non-adults aged 5+ years from two prehistoric burial mounds from the island of Tongatapu, Tonga (n=60). These two burial mounds possibly interred individuals of different social status (commoners and chiefly families).

Despite significant isotopic differences between sexes and the burial mounds when examining adult bone collagen, there were no differences between sexes or burial mounds in the childhood diet of adults (inferred via dentine collagen). While adults were potentially affected by social differences regarding food resource redistribution or as a result of differing food procurement practices, as children they may have been free of these cultural constraints.

Survivors and non-survivors of childhood displayed similar diets within the last few years of life as inferred from isotopic analyses of bone collagen. Dentine from adults displayed significantly higher  $\delta^{15}\text{N}$  values compared with bone collagen from the same individuals and the bone collagen from non-adults. Thus, it can be suggested that age affected food access for those who survived childhood. Individuals who consumed proportionately more higher trophic level protein survived into adulthood and dietary differences may have been involved in childhood mortality. Paleopathological exploration of infectious diseases and metabolic distress are utilized to further understand how resource access affected the life experiences of children in prehistoric Tonga.

### The rise of the obesity epidemic has come to a halt among young Swiss men

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Overweight and obesity (OWOB) have also risen dramatically in Switzerland since the beginning of the 1990s. In general, there is minimal nationwide information available about the

prevalence of OWOB that has been measured. A representative monitoring of the prevalence of OWOB is relevant for healthcare policy especially also for young men. The aim of the current study is to investigate for the first time measured body mass indexes (BMI) from all Swiss Armed Forced conscripts in 2013 (this represents approximately 90% of a given birth cohort due to mandatory conscription).

The national standardised 2013 conscription year BMI dataset (n=35,697) shows that the increase in average BMI and the prevalence of OWOB in young Swiss men has clearly slowed down since 2009/2010. In the largest age group of 19-year-old men (n=15,432) average height was 178.2cm (95%-CI 178.1-178.3; 2012: 178.3cm) and average weight 74.3kg (95%-CI 74.1-74.5; 2012: 74.6kg). Average BMI was 23.4kg/m<sup>2</sup> (95%-CI 23.3-23.4; 2012: 23.5kg/m<sup>2</sup>). The weight and BMI distributions were clearly right skewed (skewness 1.30 and 1.50), indicating that higher BMI values were clearly overrepresented. The prevalence of OW (BMI 25.0-29.9 kg/m<sup>2</sup>) was 18.8% (95%-CI 18.2-19.4; 2012: 19.6%) and OB (BMI  $\geq$ 30.0kg/m<sup>2</sup>) 5.8% (95%-CI 5.4-6.2; 2012: 5.9%). Similar, BMI levels of the younger and older age groups did not significantly differ from the 2010-2012 conscription years.

The stabilizing overweight trend also appears in recent Swiss schoolchildren data. Increased awareness combined with public health programmes aimed at physical activity and healthful eating habits could begin to pay off in recent years.

*Mäxi Foundation, Swiss Federal Office of Public Health*

### Validation of a Non-destructive DNA Extraction Method Applied to Forensic Samples

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In response to problems associated with sampling archaeological skeletal collections, Bolnick et al. (2012) offered a non-destructive DNA extraction protocol. Forensic cases present similar problems to archaeological and museum collections, including limited availability of sample material due to fragmentary remains, high failure rates for degraded or low-copy-number templates, the need for reanalysis, and expectations for the return of remains. Here, we assess the applicability of this non-destructive protocol to freshly acquired teeth as a stand-in for forensically-relevant samples, targeting both mtDNA and CODIS marker STR profiles. In addition, this research assesses the use of the protocol's soaking step when combined with the latter steps of a more recent extraction protocol

(Kemp et al. 2014) designed for forensic samples. This research compares these two extraction protocols for use with modern tooth samples. Preliminary results indicate the protocol's efficacy in yielding mtDNA when targeting short sequence lengths, as is appropriate for degraded samples. Results also indicate that inhibition may be a particular problem for teeth less than fifty years old when typing larger nuDNA fragment sizes, as is typically the case when targeting CODIS markers. We present our findings and recommendations for these protocols, which will allow investigators to maintain sample integrity while obtaining usable DNA profiles.

### Faunal diversity in the late Oligocene Nsungwe Formation, Rukwa Rift Basin, southwestern Tanzania

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The Nsungwe Formation is situated within the Rukwa Rift Basin, a key segment in the western Branch of the East African Rift System. In this snapshot of Cenozoic eastern Africa, proximal alluvial fan systems transitioned into a complex, volcanically-influenced landscape of fluvial, alluvial and lacustrine depositional environments. Fossil-bearing facies are dated at ~26-24 Ma via high-precision U-Pb and Ar/Ar geochronology of intercalated volcanic tuffs. Sedimentological results suggest seasonal aridity, with perennial availability of water. Results of faunal analyses demonstrate a distinctive Paleogene vertebrate assemblage. Significant primate discoveries include the first lorisisiform on Africa south of the equator, the latest record of parapathecid, and the earliest evidence of the split between cercopithecoids and hominoids. As for other Paleogene faunas from Afro-Arabia, Nsungwe mammals span a diverse range of body sizes and ecological specializations, revealing diminutive hyracoids, sengis and rodents living alongside lumbering anthracotheres. Notably, however, the fauna contains active foraging colubroid snakes, including the earliest evidence of venomous elapid predators from Afro-Arabia. Two localities preserve avian cranial and/or postcranial elements. Other vertebrates include articulated anuran, turtle and fish materials in addition to crocodylian and lepidosaurian remains. Taken together, Nsungwe Formation discoveries offer a glimpse at the evolutionary history of late Oligocene terrestrial and freshwater habitats in eastern Africa, providing data on the complex tectono-sedimentary history of the Rukwa Rift Basin. Continued exploration offers a refined perspective on the Paleogene-Neogene transition on continental Africa, with



expanded opportunities for recognizing trends in faunal diversity across habitat types and through time.

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#### **Low mineral density of a weight-bearing bone among adult women in a high fertility population**

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Evolutionary theories of aging posit that greater reproductive effort causes somatic decline given a fundamental trade-off between investing energy in reproduction and repair. Few studies in high fertility human populations support this hypothesis, and problems of phenotypic correlation can obscure the expected trade-off between reproduction and somatic condition. This cross-sectional study investigates whether greater reproductive effort is associated with reduced calcaneal bone mineral density (BMD) among female Tsimane forager-farmers of lowland Bolivia. We also investigate whether Tsimane BMD values are lower than sex- and age-matched US reference values, despite the fact that Tsimane engage in higher physical activity levels that can increase mechanical loading. To measure calcaneal BMD, quantitative ultrasonography was performed on 132 Tsimane women (mean  $\pm$  SD age = 36.7  $\pm$  15.7, range = 15 – 75) that were recruited regardless of their past or current reproductive status. Anthropometric and demographic data were collected during routine medical exams. As predicted, higher parity, short inter-birth interval (IBI), and early age at first birth are associated with reduced BMD among Tsimane women after adjusting for potential confounders. Population-level differences are apparent prior to the onset of reproduction, and age-related decline in BMD is greater among Tsimane compared to American women. Greater cumulative reproductive burden may lower calcaneal BMD individually and jointly with other lifestyle, developmental, and heritable factors. Fitness impacts of kin transfers in adulthood may determine the value of investments in bone remodeling, and thus affect selection on age-profiles of bone mineral loss.

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#### **Serotonin transporter expression in the amygdala of bonobos (*Pan paniscus*) and**

#### **chimpanzees (*Pan troglodytes*): implications for species differences in social behavior**

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Bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*) share over 99% of their genetic material with each other and over 98% with humans. Despite this, they demonstrate very different social behaviors from one another. Bonobos are more tolerant and mediate stress and conflict through sexual interactions. Chimpanzees are more aggressive and often form hunting parties and patrol territories. The amygdala is a region of the brain that plays a role in regulating social behaviors, specifically fear and aggression. Serotonin transporter (SERT) is a peptide responsible for moving serotonin, which regulates these cognitive functions. We expected that SERT expression in the amygdala of bonobos would be greater than in chimpanzees. We analyzed volume of the amygdala and its nuclei, as well as the density of SERT-immunoreactive (-ir) axons in a sample of seven bonobos and seven chimpanzees. Chimpanzees had significantly larger accessory basal ( $p < 0.005$ ) and central nuclei ( $p < 0.05$ ) volumes than bonobos. In regards to SERT-ir axon densities, bonobos had twice as many SERT-ir axons in the whole amygdala than chimpanzees ( $p = 0.004$ ). This increase in SERT-ir axons was most concentrated in the basal ( $p < 0.01$ ) and central nuclei ( $p < 0.01$ ). Our results demonstrate that differences in social behavior between bonobos and chimpanzees may be related to specific modifications in the size and SERT innervation of amygdala nuclei. The enhanced capacity of bonobos to inhibit aggressive reactivity appears to be regulated by an increase in SERT in nuclei that function in both the integration of information and the output to organize autonomic responses to social interactions.

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#### **Quantifying impairment and disability in bioarchaeological assemblages**

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Most recent work on disability and impairment in the past focuses on individuals whose physical conditions suggest a range of support systems in

prehistoric societies. This study describes a method for quantifying ill health and impairment in both individuals and in bioarchaeological assemblages that is useful for the assessment of community resilience and health, and for the consideration of social, economic, and psychological implications of skeletal pathologies, parasitism, traumata, and their sequelae as represented in the bioarchaeological record. A study of two skeletal assemblages from the US Southwest demonstrates that the Disability Weight metrics developed by the World Health Organization's Global Burden of Disease project are useful for quantifying and comparing loss of health in individuals and groups. This approach incorporates a much wider range of skeletal pathologies than typically included in population level characterizations of prehistoric health, and reveals aspects of individual and community health that are masked by paleodemographic statistics.

One anthropologically relevant issue debated by the architects of the Global Burden of Disease (GBD) Project is the assigning of Disability Weights (DWs). In earlier versions DWs for some conditions were revised through local consultations; vision loss was not perceived as equally disabling in rural and urban communities, for instance. Instead of continuing to refine DWs, the 2012 GBD applies globally uniform DWs, defining disability as loss of health, without regard to loss of productivity or income. Does this loss of local specificity enhance or dilute the utility of GBD metrics for bioarchaeology?

#### **Ancient DNA and isotopic analyses of human skeletal remains from Chelechol ra Orrak, Republic of Palau**

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In Remote Oceania, the timing and mechanisms of prehistoric human dispersal across the region has been largely reconstructed via archaeological data. While recent advances in various analytical techniques, including modern and ancient DNA (aDNA) and isotopic analysis (e.g., Sr, Pb), have provided important new insights into the human diaspora on a global scale, there has been a paucity of studies addressing population histories and genetic relationships in the Pacific. Here we present the results of pilot research involving recovery of aDNA and Sr/Pb isotopic data from human skeletal material at the Chelechol ra Orrak rockshelter in Palau, one of the oldest and largest cemeteries in the Pacific Islands (ca. 3000 -1700 BP). In this study, bone and tooth samples from 10 articulated burials were used for aDNA extraction and measurement of Sr and Pb isotopes. PCR amplification of mitochondrial

DNA (mtDNA) fragments was successful in at least two individuals. Complete mtDNA data from these individuals and others excavated from Chelechol ra Orrak allows us to investigate the origins of prehistoric Palauans and, when combined with the isotopic data, will also shed light on population movements between islands within and outside of the archipelago.

#### Principal strain orientations during biting in the faces of chimpanzees and australopiths

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A venerable hypothesis in cranial biomechanics states that the facial skeleton has a “fundamental frame.” It is thought that vertebrate cranial architecture is constrained because the face must incorporate the nasal and oral cavities, the orbits, and the feeding apparatus (teeth, chewing muscles and tongue). As a result, faces within major vertebrate clades are expected to perform biomechanically in similar ways despite seemingly extensive variation in cranial form. A key prediction of this hypothesis is that patterns of principal strain orientation are conserved across species. We tested this hypothesis in the African ape and human clade using finite

element analysis. Previously constructed finite element models of chimpanzees and australopiths (OH5, AL 444-2, MH1, Sts 5) were subjected to forces and constraints simulating bites on the molars and premolars. Resulting patterns of principal strain orientation were very similar across the chimpanzee models, despite the fact that the individuals used for modeling were intentionally chosen to bracket a large proportion of the morphological variation represented in that species. Strain orientations differed subtly among australopiths, and between australopiths and chimpanzees, but many aspects of the strain patterns are held in common among all specimens. Thus, these findings are consistent with the hypothesis that these crania share a common fundamental frame.

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#### Are Waist-Hip Ratio Preferences Adaptive? An Analysis of the Female Figure in Artwork

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Beauty, or sexual attractiveness, is both a cultural obsession and an evolutionary problem. The female waist-hip ratio (WHR) has been regarded in evolutionary literature as an indicator of overall health and fertility and it has been proposed that males have been selected to find an ideal WHR of approximately 0.70 to be most attractive. Simultaneously, however, it is observed that women often compromise their health in order to meet perceived standards of beauty. This research explores representations of women in 1045 examples of Western and non-Western, contemporary and ancient art produced for a variety of audiences in order to understand how the WHR is depicted across cultural, geographical, and temporal boundaries. WHR measurements were taken from digital versions of artwork using ImageJ software and statistically analyzed using Microsoft Excel.

Overall, artistic representations of women tend to depict unrealistically low WHRs. The distortion is not just a modern or Western phenomenon and can be seen in ancient art as well as fine and popular art. Additional comparisons between digitally altered commercial images of models and their originals suggest a directional preference towards a lower, less realistic WHR. Because this directional preference does not correspond to optimal fertility, we infer a strong influence of non-evolved cultural and individual determinants. We further suggest that WHR communicates multiple meanings that operate at different levels of behavior and abstract fantasy. The role of natural selection in determining

ideals of attractiveness has been greatly overstated.

#### Sex Biased Asymmetry in the Craniometric Variation of Modern South Africans

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Socially defined modern South Africans (SA) present with complex population histories and are fairly heterogeneous, especially coloured South Africans who demonstrate the highest levels of inter- and intra-continental admixture worldwide. Genetic literature also indicates a highly asymmetric pattern of mating between male European settlers and indigenous or slave females. Multidimensional scaling and hierarchical cluster analysis were employed to explore the possibility of a sex bias in the craniometric variation of coloured South Africans.

The sample was comprised of modern groups (South African white, black, and coloured and Thai) and possible historic, parental groups (European white, Bahutu, Basuku, and San). Mahalanobis distance matrices were subjected to hierarchical cluster analysis (HCA) and classical multidimensional scaling (MDS). Using HCA and MDS in conjunction with one another offers a means to visualize dissimilarity (HCA) and also relative proximity in a low-dimensional space (MDS).

Based on the MDS and HCA, coloured females are the most similar to San females and then modern SA blacks and Bahutu and Basuku. Although the HCA clustered SA coloured males with San and then Basuku, coloured males are depicted as a largely unique group using MDS. For both sexes, the Thai and Historic White samples are the most divergent groups. The MDS craniometric plots are overwhelmingly similar to MDS plots of mtDNA Hg frequencies and NRY Hg frequencies, which substantiates the existence of a sex bias in SA coloureds. The current study accentuates agreement between genetic and craniometric data and population history.

#### Comparative analysis of trabecular bone structure and orientation in South African hominin tali

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The talus is a frequently preserved bone in the fossil record. Studies of external morphology conclude most hominin tali manifest mosaics of human-like and ape-like features. The talus transmits locomotor loads through the ankle joint, and thus its internal structure is hypothesized to reflect accommodation to such loads. Here we quantify and characterize trabecular bone morphology within South African tali attributed to *Australopithecus africanus* (StW 102, StW 363, StW 486) and *Paranthropus robustus* (TM 1517). Comparisons are made with modern humans, great apes, and an East African hominin talus attributed to *Paranthropus boisei* (KNM-ER 1464). Using micro-CT images of the fossil tali (25 $\mu$ m resolution) and Avizo Fire software, trabecular bone was segmented from surrounding matrix to quantify patterns in distribution and primary strut orientation for 9 regions of interest across the talar trochlea. Discriminant function analysis aligns trabecular bone morphology within StW 363 most closely to that of *Pan* and *Gorilla*, while KNM-ER 1464 most resembles modern humans; other South African tali are intermediate. Primary strut orientation best discriminates extant groups in the anterior-medial regions of the talus. KNM-ER 1464, StW 102, StW 363 and TM 1517 fall within the range of modern humans, where trabeculae appear oriented to distribute compressive loads distally toward the talar head. Primary strut orientation in StW 486 falls closer to apes. These results provide evidence that trabecular strut orientation and shape can discriminate among species characterized by different locomotor foot kinematics, and thus they may help to infer habitual joint postures in fossil hominins.

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#### **Cortical and Trabecular Bone Structural Variation in the Human Knee Joint**

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The knee joint is characterized by functional asymmetry of the medial and lateral compartments. In humans, the medial compartment of the knee transmits higher loads than the lateral compartment, and functions as a static axis upon which the knee rotates through lateral condylar movement. This study quantifies density variation in the subchondral cortical bone together with the structure of underlying trabecular bone in the distal femur and proximal tibia in a diverse sample of modern humans. MicroCT scans were collected for paired femora and tibiae. Subchondral bone density patterns were visualized using false-color maps and three-dimensional trabecular bone structure was

quantified. Subchondral density mapping revealed a consistent pattern of larger regions of high density in the medial compartment compared to the lateral compartment. Trabecular bone showed no significant difference in bone volume fraction between the medial and lateral compartments. However, the medial condyle had significantly more anisotropic trabeculae than the lateral in both femur and tibia. In addition, trabecular bone in the medial tibial condyle was significantly more anisotropic than the corresponding medial femoral condyle. These results indicate that subchondral cortical bone and the underlying trabecular bone reveal complementary locomotor signals for habitual bipedal loading. The subchondral bone provides a clear signal of the differential loading and suggests a habitual loading posture of a slightly flexed knee. The 3D arrangement of trabecular bone reveals the contrasting patterns of mobility in the lateral compartment and immobility of the medial compartment.

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#### **An ill-named pair: Popliteal groove size does not indicate a high degree of popliteus muscle activity**

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A recent reconstruction of the locomotor pattern of *Australopithecus (A.) sediba*, suggested they utilized a gait with an unusual degree of hyperpronation, partly based on the presence of a deep popliteal groove on the distal femur thought to be caused by an enlarged popliteus muscle. The function of the popliteus muscle however, has only been explored in humans, and very little is known about the relationship between the size of the groove and activity (or size) of the muscle. We sought to explore the functional role of the popliteus in nonhuman primates, and clarify the relationship between the popliteus muscle and the popliteal groove through dissections of the popliteus muscle-tendon complex and measurement of popliteal groove dimensions. We collected electromyographic data on two humans, two chimpanzees, and one orangutan; linear and angular measurements of the popliteus groove on 15 catarrhine species; and performed soft tissue dissection on a chimpanzee, orangutan, mandrill, rhesus macaque, and a black and white colobus. We addressed two questions: 1) when is the popliteal tendon within the groove, and 2) during what gaits is there high popliteus activity? The dissections revealed that the popliteal tendon is only within the groove during acute knee flexion. Popliteus muscle activity was highest during climbing for all subjects except one chimpanzee, but popliteus muscle activity did not coincide with acute knee flexion in any gait observed. Although there is predictable variation in the popliteal groove across catarrhines, there appears to be no

functional link between the popliteus muscle and groove.

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#### **Preliminary findings on demography and dispersal of Kinda baboons (*Papio kindae*)**

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This study reports on demography and dispersal patterns of wild Kinda baboons (*Papio kindae*) of Kasanka National Park over a period of 38 months. These data come from the first long-term project to study Kinda baboon behavior. Given their phylogenetic proximity and ecological overlap with the yellow baboon (*Papio cynocephalus*) we tested the hypothesis that Kinda baboons would exhibit comparable demographic and dispersal patterns. Demographic data presented here were first collected in 2010 and continued through September 2014. Group size fluctuated over the study period between 65 and 54 individuals. The number of non-natal adult males ranged from 4-7, and the number of adult females ranged from 15-17. Female interbirth interval ranged from 15 to 27 months with an average of 22.3 months. Females began exhibiting sexual swellings at approximately 5 years of age. Forty-three infants were born during the study period. Infant mortality (death within the first year) over the study period was 17%. Over the study period, 14 adult males disappeared or emigrated while 4 males immigrated into the group. Five females, 3 juveniles, and 7 infants disappeared and were presumed dead from natural causes, predation or poaching. This study shows that Kinda baboons are female philopatric and male dispersing, as is the case in most other "savanna baboons" including yellows. General demography of the study appears to be similar. Further analysis of the social structure of this Kinda population will shed light on the similarity and differences seen between Kinda and other baboons.

#### **Three-dimensional shape analysis of the distal femur of *Australopithecus sediba***

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The knee has been central to debates concerning the walking kinematics of early hominins because of its weight bearing role during locomotion. Here we carry out a three-



dimensional geometric morphometric analysis of the distal femur U.W. 88-63 (*Australopithecus sediba*) comparing it to extant and extinct hominids.

Virtual surface models were created of 93 distal femora representing three extant hominid species and six hominid fossils, including the specimen U.W. 88-63. To quantify shape variation, sliding semi-landmarks were distributed across each distal femoral articular surface. A combination of statistical and geometric approaches was used to reconstruct the missing medial condyle of U.W. 88-63 based on the extant and extinct reference samples. Two separate procedures, Generalized Procrustes Analysis and a functionally constrained Procrustes, were used to align all specimens. Parallel analyses were conducted using the coordinates representing only the condyles and the patellar surface. Shape variation was summarized using between group principal components analysis and shape differences were quantified using partial Procrustes distances and root mean square values.

U.W. 88-63 lies outside the shape space bound by the reference sample, but is closest in shape to the average modern human distal femur relative to other species averages. Separate analyses of the condyles and patellar surface reveal that the condyles of U.W. 88-63 are closest in shape to other australopithecids, while the patellar surface is closest in shape to modern humans. U.W. 88-63 appears to combine early hominid condyles with a more modern patellar surface.

#### **Two evolutionary models of suicide stand up against the ethnographic record**

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In the late 1990's non-infectious health problems surpassed infectious disease as the major contributors to global disease burden, with psychiatric problems playing a prominent role. According to the World Health Organization, suicide is a leading cause of death among those in the age range of 15-44, and attempted suicides are the sixth leading cause of disability

Two evolutionary theories of suicide were tested against the ethnographic record: 1) the inclusive fitness model posits that suicide is resorted to when one has low reproductive potential and is a burden on kin, thus suicide is a means to increase one's inclusive fitness; 2) the bargaining model, which is based on costly signaling theory, argues that most suicidal behavior is non-lethal and functions as a credible signal of need.

Data were obtained from the probability sample of the Human Relations Area Files, which yielded 476 extracts from 57 cultures. Each

theory was operationalized into a set of variables, and the extracts were coded based on levels of support for each model by two independent coders.

Though there was little evidence for the inclusive fitness model, the variables, when they did occur, clustered together and correlated positively with age and latitude. This suggests that this model might best apply to the elderly and infirm under harsh environmental conditions. In contrast, there was evidence for the bargaining model in most cultures, though the variables correlated negatively with age, suggesting that using non-lethal suicidal behavior to signal need is a strategy of young, healthy adults.

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#### **Variation in number of vertebrae in humans**

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Species differ in variability in number of vertebrae; humans are among those species with higher variability. This study uses human skeletons from the Hamann-Todd and Robert J. Terry Collections to quantify variability in number of presacral vertebrae and to consider correlates with this variability. A total of 1,020 individuals (259 females and 761 males) between ages 20 and 49 were studied; all individuals have a 5 segment sacrum. Results show that the sexes differ significantly in number of presacral vertebrae (modal number is 24), with 5% of females and 10% of males having a nonmodal number; males have a higher prevalence of 25 vertebrae. An extra vertebra is positively associated with presence of a nearthrosis between the last lumbar and first sacral vertebrae; nearthrosis is associated clinically with pain in the lower back and leg. Conversely, an extra presacral vertebra is negatively associated with presence of a cervical rib; cervical rib is associated clinically with thoracic outlet syndrome. Using the sample of males, individuals with 25 presacral vertebrae have significantly lower means than those with 24 vertebrae for these variables: (1) summed height of vertebral bodies for vertebrae 2-24, (2) length and width of sacrum, and (3) anteroposterior diameter of pelvic inlet. The two groups of individuals do not differ significantly for these variables: (1) lengths of femur and clavicle, (2) femoral head diameter, and (3) other pelvic measures, such as transverse diameters of inlet and outlet. Number of vertebrae has clinical implications; etiology of numerical variation is discussed.

#### **A preliminary paleoecological analysis of newly discovered fossiliferous localities at the middle Miocene site of La Venta, Colombia**

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La Venta is a Colombian Middle Miocene paleontological site that has yielded fossils critical for understanding the evolution of the platyrrhines and the endemic South American vertebrate fauna that existed prior to the Great American Interchange. Despite being highly fossiliferous, no systematic fossil collection has been conducted at La Venta since the late 1980s. During the summers of 2013-2014, our team began field expeditions to both previously known and unexplored areas of La Venta. Here we present our initial discoveries and analyses of both primate and broader vertebrate fauna with particular concentration on those collected from newly discovered localities.

In two field seasons, we have identified 25 new localities and collected over 1500 individual fossil specimens, including a new calcaneum of *Neosaimiri* from the Monkey Beds of the Villavieja formation. This layer and the layer below the Tatacoa Sandstone beds from the La Victoria formation were the most diverse and the only layers to yield significant numbers of mammals. Fossil Crocodylia and Testudines were common throughout all fossiliferous layers, although other sauropsids were also discovered, notably snake vertebrae which augment a clade previously known from a single specimen. Osteichthyes are abundant in some layers, but are nearly absent in others. Fluctuations in faunal percentages may correspond with changes in the paleoecology of the proto-Magdalena River Basin through time. Our two expeditions to La Venta have yielded many fossils that demonstrate the diversity and importance of these formations and impel continuing field expeditions in future seasons.

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#### **Femur Subtrochanteric Shape and Ancestry Assessment in Modern Japanese and Thai Individuals**

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Ancestry determination is often the most difficult component of the biological profile during the analysis of skeletonized remains. While several

reliable morphometric and morphoscopic methods exist for the cranium, the fragmentary and incomplete nature of remains from bioarchaeological and forensic contexts necessitates the use of less accurate postcranial methods. In particular, anterior-posterior (A-P) and medial-lateral (M-L) measurements and the platymeric index (PI) of the femur subtrochanteric region are regularly employed. It is commonly thought that Asian populations exhibit medio-laterally broad (platymeric) femora, while non-Asian populations exhibit more rounded (eurymeric) femora. However, the association of platymeria and Asian populations is based mainly on data obtained from Native American archaeological assemblages, and little work has assessed subtrochanteric form in modern Asian individuals. This study examines subtrochanteric form in modern samples of 287 Japanese (male=217; female=70) and 149 Thai (male=104; female=45) individuals, 17–96 years old. The results indicate that the Japanese and Thai samples are similarly platymeric (Japanese=66.9%; Thai=65.1%), eurymeric (Japanese=32.1%; Thai=32.9%), and stenomic (Japanese=1.0%; Thai=2.0%), and that the samples' PI distributions are not significantly different. Additionally, the Japanese and Thai samples are less platymeric than Native American groups, and the use of Native American A-P and M-L sectioning values results in low correct classification rates for the Japanese (43.9%) and Thai (52.3%) samples. As such, subtrochanteric ancestry assessment methods developed on Native American remains exhibit reduced discriminatory power when applied to these two modern Asian groups. However, adapting femur subtrochanteric methods with appropriate geographic and contemporaneous samples can increase accuracy.

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#### **Comparisons of strength and predictability of Neanderthal and modern human femora under loading conditions simulating irregular steps**

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It has been hypothesized that the distinctive anatomy of the Neanderthal femur is an adaptation to withstanding irregular loads associated with traversing uneven terrain. This hypothesis was tested using finite element analysis, in which finite element models of Neanderthal and modern human femora were subjected to simulated irregular steps. Resulting data allow an assessment of femoral strength in each species, as well as the degree to which shape affects the predictability of the stresses experienced by the femora.

The Neanderthal and human femora were initially each subjected to identical loads, but the Neanderthal was also subjected to scaled loads such that differences in stress between the human and Neanderthal reflect differences in shape but not size. A baseline analysis simulated the moment of heel strike during normal bipedal walking. Additional analyses then explored the consequences of an irregular step, such as a stumble, in which the magnitude of the acetabular reaction force was tripled. Additionally, the orientation of acetabular forces were varied by five degrees anteriorly and five degrees laterally. Results indicate that in humans the femoral neck is weaker than in Neanderthals, but in Neanderthals the distal diaphysis is weaker compared to humans. These differences are attributed to the longer femoral neck in humans, and the more distal point of maximum curvature in Neanderthals. Thus, the Neanderthal femur is not uniformly stronger than that of modern humans. Moreover, Neanderthal femora experience a less predictable stress environment than modern humans.

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#### **The significance of allogrooming to pair-bonded owl monkeys (*Aotus spp.*)**

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Allogrooming has an important impact on the role of social bonding between primates, and subsequently on an individual's reproductive success. Specifically, grooming has been hypothesized as a mechanism of reinforcing the pair bond in monogamous primates. However, in the owl monkey (*Aotus spp.*) male-female dyad allogrooming has been reported to occur at low rates typically before mating. At the DuMond Conservancy for Primates and Tropical Forests grooming between the male-female dyad has been observed to occur more frequently than previously documented. Between October 2012 and December 2013, 13 *Aotus* pairs (n=26) were observed over 80 hours. Each pair was observed between four and eight hours. Grooming behavior was recorded using continuous recording for twenty minutes. A total of forty-seven allogrooming bouts were recorded, and males were responsible for forty of these bouts. A difference was found between male and female likelihood to allogroom their partners using a two-tailed Mann Whitney-U test [N1= 13, N2 = 13, U(1) = 39, p = 0.017395]. In this study, grooming occurred mostly between the male-female dyad, and in contrast to published data occurred infrequently in relation to mating behavior. This study suggests that grooming between the male-female *Aotus* dyad is a likely means to sustain the pair bond as in other monogamous primates. Differences that exist

between this study and previous ones are intriguing, and possible explanations will be discussed.

#### **Body and Brain: Anatomy of team-based learning in a preclinical science course**

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In 2009, the Duke Doctor of Physical Therapy (DPT) Program embarked on a significant pedagogical shift from a traditional lecture-style to a team-based learning (TBL) curriculum. This shift was driven by at least three factors: 1) today's 'digital natives' learn differently from students a generation ago; 2) an increase in competency-based demands, including working in interdisciplinary teams; and 3) recognition that educational activities that train students to function effectively in teams are needed to foster core competencies in clinical practice.

The foundational sciences were at the forefront of the transition to TBL. Body and Brain is a newly developed, team-taught, two-semester course that employs TBL to comprehensively explore the human body and brain. We begin with an emphasis on gross anatomy and relationships among musculoskeletal, neurological, and vascular systems of the human body, with integration of palpation skills. In Body and Brain II we progress to head and neck anatomy and transition into clinical neuroanatomy and neurophysiology of the central nervous system. Strategically targeted content in embryology, histology and pathology are embedded throughout.

To develop and support a culture of TBL, we formulated a set of curricular principles and educational practices, grounded in our core values, which guide the implementation of Body and Brain. Practices that reflect our core principles include learner readiness assurance, teamwork, real-time problem solving, peer assessment, and summative learner assessment. Positive outcomes include diverse and innovative learning experiences, recruitment and application of core knowledge, trust among team members, and enhanced learner engagement, responsibility, professionalism, and satisfaction.

**Do diet and evolutionary history predict variation in life history variables better than environmental harshness for lemur traits?**

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Lemurs exhibit a suite of traits unique among primates, including rapid infant development, fibrous diet, and diverse activity patterns. These traits are hypothesized to be adaptive to harsh Malagasy environments, resource extraction, and/or represent recent evolutionary transitional states. We compiled data on morphology, life history (LH), environment and diet for 100+ taxa to test these hypotheses: 1) LH traits are predicted by environment, diet, and/or activity pattern, and 2) lemurs differ from other primates in LH traits (Phylogenetic ANCOVA). We tested for uniqueness of adaptive regimes by dietary niche. Lemurs differ significantly from other primates in shorter weaning times, gestations, and inter-birth intervals (IBI), as well as larger litter size (likelihood ratio test, LRT, vs null hypothesis = 9.63,  $p=0.047$ ). Diet predicts LH, with shorter IBI and weaning times in folivores than frugivores or omnivores (LRT vs null = 7.10,  $p=0.03$ ). An adaptive peak with high selective constraint (alpha parameter  $\sim 0.15$ ) best fits the model. Annual precipitation (harshness variable) does not explain variation in LH. Life history likely evolved towards unique optima with different levels of selective constraint among dietary regimes: folivores have fastest life histories/ weakest selective constraints whereas frugivores and omnivores have slower life histories/ stronger selective constraints. Lemurs have faster LH than other primates, with diet, not environmental harshness, being the salient predictor of their LH dynamics. The folivore fast-lane is an adaptive optimum, suggesting resource extraction, rather than adaptation to a harsh environment or evolutionary disequilibrium, as the primary driver of lemur life history.

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**Rates of dental microwear in laboratory primates track changes in food items consumed**

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Dental microwear analyses have yielded many insights into diet and dental function, yet most dental microwear studies have involved analyses of museum samples, which typically lack detailed information about the foods consumed by each individual just before death. Recent *in vitro* work has suggested that exogenous grit is a more likely cause of dental microwear, because most primate foods are not hard enough to scratch enamel. As noted in these same studies, however, the hardness of food items is but one variable to be considered in the etiology of microwear patterns.

Ultimately, the causes and interpretations of dental microwear must be confirmed by empirical studies with live animals consuming known diets under experimental conditions. Toward this end, we took dental impressions on five *Cebus apella* immediately before and shortly after they were fed Brazil nuts (*Bertholletia excelsa*) or a mixture of Brazil nuts and other foods. Scanning electron microscope analyses of rates of dental microwear on the resultant casts indicate that feeding on Brazil nuts not only caused microwear on teeth, but dental microwear rates changed in proportion to the amount of Brazil nuts consumed and/or the side of the mouth on which they were chewed. In summary, these results empirically demonstrate that feeding on foods less hard than enamel can create dental microwear. They also illustrate some of the factors, such as individual differences in feeding styles, which can contribute to the process and rates of dental microwear formation.

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**Primatologists' engagement with communities in Madagascar**

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Community interaction is a critical component of conducting primatological research. Primatologists interact with local communities in a variety of ways for a range of reasons. Here I focus on primatologists conducting research in Madagascar, and discuss the types of interactions that these individuals have with local communities. Researchers often interact with community members as teachers, students, collaborators, and scientific experts. I highlight the proximate and ultimate goals of these interactions from the researchers' perspective. Proximate goals focus in part on benefits to research. For example, training technicians and local graduate students in new field methods helps facilitate data collection. Local knowledge of the field site and the location of animals, previous (published and unpublished) research,

and the suitability of certain methods can be invaluable to researchers. Proximate goals also include the dissemination of results to policy makers, and fulfilling requests (e.g., teaching English) from community members. Ultimate goals include building capacity within the country at universities and at specific field sites, and developing long-term research collaborations. It is hoped that through these ultimate goals, researchers' interactions promote scientific literacy in university-educated participants and non-formally educated locals, as well as a non-commoditized valuation of the natural environment. I also note new plans for more active and measurable community engagement as a result of incorporating capacity building during grant proposal preparation. Finally, I discuss some costs and benefits of the various types of interactions that researchers experience, and suggest how we can move forward to assess whether we are reaching our goals.

**Vervet monkeys prioritize highly rewarding food sites more when competitors are present**

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Optimal foraging theory (OFT) predicts that animals should attempt to maximize their food intake while exerting minimal energy. Food sites should, therefore, be visited in order of proximity. However, resources vary in multiple attributes, so it may be beneficial to bypass some sites and visit more productive areas first. We used foraging experiments on wild vervets (*Chlorocebus pygerythrus*) at Lake Nabugabo, Uganda to determine whether high-reward food sites were prioritized. Five baited platforms were set in a large pentagon (5 m apart) within the range of one group. Trials usually consisted of single foragers (N=436) but when multiple individuals participated (N=64), food competition occurred. In experiment one (N=100 trials), platforms were baited equally. Individuals immediately found the shortest path and there was no relationship between experience and distance traveled. From experiment one, expected numbers of "first visits" to each platform were calculated for the remaining experiments, where one (N=300 trials) or two (N=100 trials) platforms in the pentagon were six-times more rewarding than others. In combined results from all experiments with high-reward sites, individuals did not travel to highly-rewarding platforms first ( $P=0.748$ ), unless competitors were present ( $P=0.027$ ). Monkeys also passed less productive sites to get to highly-rewarding platforms more often when in competition ( $P=0.066$ ). In natural foraging situations, prioritizing more productive sites during competition would allow individuals to increase food acquisition but at the expense of travel costs. Vervets foraging alone acted in a



way consistent with OFT, accessing food sites in order of proximity and saving on travel costs.

**Bioarchaeological evidence physiological for trade offs in response to early-life stress among Late/Final Jomon period foragers**

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This study evaluates two hypotheses that address how Late/Final Jomon period people responded to early-life stress using linear enamel hypoplasia (LEH) and incremental microstructures of enamel. The first hypothesis predicts that Jomon people who experienced early-life stressors had greater physiological competence in responding to future stress events (predictive adaptive response). The second hypothesis predicts that Jomon people traded-off investments in future growth and maintenance when early investment in growth and survival was required (plasticity/constraint). High resolution tooth impressions were collected from intact, anterior teeth and studied under an engineer's measuring microscope. LEH were identified based on accentuated perikymata and depressions in the enamel surface profile. Age of formation for each LEH was estimated by summing counts of perikymata and constants associated with crown initiation and cuspal enamel formation times. The relationship between age-at-first-defect formation, number of LEH, periodicity between LEH, and mortality was evaluated using multiple regression and hazards analysis. A significant, positive relationship was found between age-at-death relative to age-at-first-defect formation and a significant, negative relationship was found between number of LEH relative to age-at-first-defect formation. Individuals with earlier forming defects were at a significantly greater risk of forming defects at later stages of development and dying at younger ages. These results suggest that Late/Final Jomon period foragers responded to early-life stressors in a manner consistent with the plasticity/constraint hypothesis of human life history. Late/Final Jomon period individuals were able to survive early-life stressors, but this investment weakened responses to future stress events and exacerbated mortality schedules.

**A reassessment of the taxonomic validity of the *Australopithecus sediba* mandibles**

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The mandibular remains of *Australopithecus sediba* consist of two relatively complete specimens—MH1 (subadult) and MH2 (adult). The shape difference in their rami is marked, which the original describers link to ontogenetic and/or intraspecific variation. However, others argue that this difference exceeds the variation expected in a single species, placing MH1 in *Australopithecus* and MH2 in *Homo*. To address this debate, this study evaluates variation in *A. sediba* in the context of extant great ape and human ontogenetic variation, with the working null hypothesis that the amount and pattern of shape variation represented by MH1 and MH2 are consistent with intraspecific variation in extant species.

To test this hypothesis, two-dimensional sliding semilandmarks were digitized on mandibular rami of *Gorilla*, *Pan*, *Pongo*, *Homo sapiens*, MH1, and MH2. The missing MH2 coronoid was reconstructed using thin plate spline and regression techniques. Shape differences (measured using Procrustes distances) were calculated between pairs of extant individuals of similar ages to MH1 and MH2, and compared to the distances between MH1 and multiple reconstructions of MH2. Although the distances between MH1 and MH2 are large, they only exceed the 95% confidence interval of a single species (*Pongo*). Thus, the hypothesis that MH1 and MH2 belong to a single (albeit highly variable) species cannot be refuted. Notably, we do not observe significant ontogenetic shape differences between the age groups represented by MH1 and MH2 in any extant species. These results challenge previous interpretations that the difference between MH1 and MH2 is due to ontogenetic shape variation.

**Developmental and epigenetic responses to the environment: mechanisms for the embodiment of health disparities in New Zealand**

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The tendency for patterns of health and disease to map onto race, ethnicity and other social groupings has generated interest in understanding the underlying causes of these disparities. Current evidence does not support a strong role for DNA sequence variation as a cause of group level health disparities, and interest in the possible role of developmental plasticity and environmentally-sensitive epigenetic mechanisms has increased. Here we discuss our findings from New Zealand which support a role of developmental plasticity and environmentally-induced epigenetic change as an explanation for the mapping of biological disparity onto socially- and economically-patterned disparities. We found that mothers who

were poorer and who experienced ethnic discrimination had higher cortisol during pregnancy, and that offspring of these women exhibited greater cortisol response to vaccination. Poverty in our sample was also associated with decreased methylation at the glucocorticoid receptor gene (*NR3C1*) measured in buccal cells in 6 week old infants ( $p < 0.03$ ), pointing to socially-driven epigenetic change. These findings shed light on the early life and intergenerational origins of changes in stress physiology that are known to influence a range of health disorders across the lifecycle, and could be an important contributor to ethnic and class-based disparities in health in New Zealand. We argue that environmental signals common in contemporary ecologies trigger responses that are maladaptive and heighten risk for disease. From an applied perspective, these findings add to growing evidence that stressors experienced by one generation can lead to durable changes in health among future generations.

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**Do kinematics signal energetic optimality? Evidence from human walking studies**

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Previous research has indicated that humans have an "optimal" speed (a speed at which cost of transportation is lowest), and that people preferentially choose to walk around this speed; however, it is unknown how people gain the real time feedback necessary to determine optimality. Gait kinematics have been indicated as a potential feedback mechanism and here we evaluate energy and kinematics on humans walking at multiple inclines.

Participants ( $n=5$ ) were evaluated in two trials in which they walked at four different speeds on both a level and 12% incline, while their energy consumption was monitored; participants identified preferred speeds for each grade at the end of each trial. Posterior video data were analyzed to determine step width and contact time using Kinovea software. Stride length was calculated from stride frequency measured during each speed.

People were better able to detect their optimum speed at the incline. Stride length increased linearly with speed nearly identically (slopes 4.5% different) for both the level ( $R^2=0.93$ ) and inclined ( $R^2=0.90$ ) conditions. Contact time decreased linearly nearly identically (slopes 10.8% different) for both the level ( $R^2=0.96$ ) and inclined ( $R^2=0.90$ ) conditions. Neither stride length nor contact time showed curvature or other cues as to identifiable optimality. Step width showed a wide variation between and within each participant, with a greater coefficient

of variation for the incline condition (21.5% increase) and for speeds away from the optimum (34% at the incline). It is thus possible that increased variation gives an indication of energetic cost while walking.

#### Success Rates of Sex Estimation by Forensic Anthropologists using Real-life Forensic Casework Data

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A common task in biological anthropology involves the estimation of the biological sex of a decedent based upon their skeletal remains. Various methods for making this estimation, both morphological and metric, are based upon analysis of skeletal collections of known sex, and most include a theoretical success rate derived from the ability of the method to discriminate between males and females found in that skeletal collection. However, the success rates of sex estimation methods in actual forensic casework have rarely been studied.

This research used sex determinations based upon DNA results from 360 actual forensic cases to develop "real-life" success rates for sex estimations conducted by forensic anthropologists based upon skeletal material. Cases included varying amounts of skeletal material available for analysis, varying levels of education and certification of the anthropologist, and information regarding specific techniques used for sex estimation. The overall rate of correct sex estimation from these cases is 94.7%, with increasing success rates as more skeletal material is available for analysis. For example, success rates varied from 60.0% when only the mandible was available, to 97.8% when a complete or nearly complete skeleton was available. Success rate also increased as the education level and certification status of the examiner increased. A large portion of incorrect assessments resulted from cases where only one skeletal element was available for analysis, suggesting caution should be employed, including more use of the category "undetermined sex", when estimating sex for these types of cases.

#### An odontometric analysis of interregional biological variation in the prehistoric Midwest

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The lower Illinois River valley (LIRV) received its most dense prehistoric occupation during the

Late Woodland (AD 300-1000) and Mississippian (AD 1000-1400) periods. Cultural transformations over this timespan are often perceived as a result of extralocal contact with the adjacent American Bottom (AB) region, which is widely held as the birthplace of Mississippian culture. Similarity in material culture elements between regions supports this premise, but a direct assessment of biological evidence for interregional interaction is lacking. The purpose of this study is to evaluate whether shifts in material culture that occurred during the Mississippian period in the LIRV coincide with increased interaction with groups from the AB. Hypotheses related to this model are tested using odontometrics as an indicator of biological variation.

Results show local trends that indicate small-scale contact with the American Bottom was likely important for site-specific cultural development in the LIRV. This is most apparent at the Schild site, where a decrease in biological distance to the AB Cahokia site during the Mississippian period was observed. Similarity between LIRV and AB females during the Mississippian period was evident in sex-based biological distance analyses, most notably between the Schild and Cahokia sites. This observation can be explained by greater female mobility or a common source of gene flow that resulted in homogenization of the groups investigated. Overall, the data suggest a variable transition to Mississippian culture in the LIRV that was locally impacted by interaction with groups from the AB.

#### Do marmosets use olfactory cues to identify high quality food resources?

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Marmosets use olfactory communication in multiple contexts, including depositing scent marks on gouge holes during exudate feeding. Data from other mammals suggests that scent marking of foods helps identify high quality foods at a later date. As gouge holes are stationary and can produce exudate over extended periods, marmosets may use olfactory cues to identify profitable gouge holes. We tested the hypothesis that marmosets use scent marks to indicate food quality. We conducted choice tests on two captive common marmosets (*Callithrix jacchus*) to determine whether animals 1) preferentially scent mark high quality foods, 2) preferentially re-gouge these high quality foods, and 3) prefer to feed on foods that were previously scent marked. We found that marmosets were significantly more likely to deposit scent marks on high quality gouge holes. Animals also spent more time re-gouging and

revisiting high quality holes. In contrast, marmosets did not prefer to feed on scent marked foods, although this pattern may have resulted from rapid habituation to the experimental setup. While both preliminary and partial, our data support the hypothesis that marmosets use olfactory cues to denote food quality during exudate feeding. Given the limits of captive tests, further observation in wild animals with gouge holes that vary naturally in exudate quality will likely yield additional insight into how marmosets use scents and olfaction in exudate feeding.

#### The effects of trunk morphology on bipedal locomotion in chimpanzees (*Pan troglodytes*)

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Functional interpretations of the earliest known hominins have often drawn attention to differences in trunk morphology that characterize apes, humans and fossil hominins. Chimpanzees are seen as having rigid lumbar regions that are entrapped by projecting iliac blades. The aim of this study is to test the hypothesis that chimpanzees are characterized by truncal immobility by documenting three-dimensional motion of the thorax, lumbar region, and pelvis in humans and chimpanzees during bipedal locomotion at similar dimensionless speeds. Marker clusters on each segment were recorded using a four-camera motion capture system (Xcitex Inc., Boston, MA), and were used to calculate tilt, list, and rotation of each segment.

Initial results indicate that differences exist in the phasing and range of motion (ROM) of trunk segments between chimpanzees and humans. In the frontal plane, the entire chimpanzee trunk listed over the stance side limb, whereas humans exhibited minimal lumbar motion, a small thoracic list over the stance limb, and a drop of the pelvis to the unsupported side. In the transverse plane, and in contrast to humans, the chimpanzee thorax rotated in phase with the lumbar region and pelvis. However, rotation of the chimpanzee thorax was reduced ~40% relative to rotation of the pelvis, indicating a trunk that is not completely immobile. Differences in segmental ROM and phasing were less striking in the sagittal plane. These results highlight the effects of the derived human trunk, and will allow us to evaluate how pelvic and vertebral morphology may have affected motion in fossil hominins.

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### CT Evidence of Atherosclerosis in Ancient Mummies: The Horus Study of 220 Mummies from 5 Continents

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**Background:** Atherosclerosis is thought to be a disease of modernity and related to modern lifestyles. However, some bioarchaeologic evidence suggests it was present in ancient times. It is not known how prevalent atherosclerosis was before the modern era.

**Methods:** In order to search for atherosclerosis in pre-industrial people, we reviewed whole

body CT scans on 220 mummies of individuals from 6 different geographic regions and spanning a time horizon of over 5000 years. The mummies came from ancient Egypt, ancient Peru, what is now the southwestern US, the Aleutian Islands, nomads of the Gobi Desert, and a Bronze Age European. Atherosclerosis was considered definite if a calcified plaque was seen in the wall of an artery and probable if calcifications were seen along the expected course of an artery.

**Results:** Probable or definite atherosclerosis was seen frequently in all geographic populations and in all vascular beds. Over one third of the mummies examined had definite or probable atherosclerosis. Age at time of death was positively correlated with atherosclerosis and with the number of arterial beds involved.

**Interpretation:** Atherosclerosis was common among 5 pre-industrial populations including pre-agricultural hunter-gatherers and was seen in the Bronze Age European. It was prevalent in ancient times across a very large span of the globe and dating back over 5000 years. While atherosclerosis is frequently assumed to be a disease of modernity, the wide variety of diets and lifestyles represented by the people in this study suggests that humans have a basic predisposition to the disease.

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### You can't bogart that grass: Dominance and resources in geladas

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Gelada females form strict dominance hierarchies and close social bonds – two indicators of within-group competition for clumped resources. Yet geladas forage on dispersed and plentiful food (grass), presenting a puzzle for socioecology. Here, we used behavioral and genetic sampling to address this paradox in geladas living in the Simien Mountains National Park, Ethiopia. We sought to: (1) confirm that dominance rank and/or genetic relatedness mediate social bonds, and (2) take advantage of the multi-level social structure of geladas, which consists of multiple reproductive units, to assess how variation across units influences the nature of social bonds. Specifically, we focused on variation in relatedness, the nature of the dominance hierarchy (e.g., despotic vs. egalitarian), and the number of females (from 1-12). First, we found that, even though females in the same unit were

closely related, females still preferentially bonded with the closest of these relatives. Also, among females that were close kin, those that were also close in rank formed significantly stronger bonds than those more distantly-ranked. Second, we found a trend across units: as unit size increased, the mean relatedness and the strength of female social bonds both decreased. Finally, unit size significantly predicted the strictness of the dominance hierarchy, demonstrating an inverted U-shaped relationship where the strictest hierarchies were found in intermediately-sized units. Therefore, although female geladas can form dominance hierarchies and social bonds, the degree to which they do so is influenced by unit size, perhaps suggesting that within-group competition is over social rather than ecological resources.

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### Operationalizing Race, Resisting Racism: bridging biological, political, and lived experiences."

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Social and biomedical scientists have made immense efforts to study human variation; however, while researchers agree that variation is integral to the human experience, they diverge in how variation is theorized and operationalized. Race is particularly problematic because it is a cultural concept that contains implicit and explicit understandings of how collective bodies differ. In this paper, we propose a theory of race that more fully accounts for racial experience and human biological diversity within the same ontological sphere. That is, rather than postulating race as a social construct opposite to the nature of biological diversity, we take racial experience to be an embodied experience that exists within the same realm of reality as biological variation. Consequently, we argue that an anthropology of race need not explicitly translate into an anthropology of antiracism. We explicitly address how such a theoretical bridge can (1) be operationalized within contemporary anthropological research and (2) help formulate a critique of racial politics and pedagogy in the United States and beyond. First, operationalization needs to inductively account for racial experience without limiting that experience to negative health consequences. Once the dimensions of racial experiences are fully delineated, then a more robust antiracist anthropology can be deployed to ameliorate problems such as racial health disparities. Second, anthropological interventions in the politics and pedagogy of race must move away from notions of "race as a social construct" that



the public can perceive as a dismissal of how they meaningfully experience race.

#### Clade-specific SNPs reveal hybrid ancestry of individuals in captive guenon populations

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Molecular phylogenies of the guenons indicate that polytypic species groups (*i.e.* *mona* grp, *cephus* grp, *nictitans* grp, *lhoesti* grp) form monophyletic clusters, as proposed by earlier morphological analyses. Subsequent studies have identified synapomorphic X- and Y-chromosomal single nucleotide polymorphisms (SNPs) useful for detecting introgression between hybridizing members of different species groups. Here we put these assays to the test by applying them to samples from two captive guenon populations. In one case, the separate species lineages of a known hybrid were confirmed using these methods. In a second case, a hybrid animal was discovered through these assays and later confirmed by a review of zoo records. The results demonstrate the utility of clade-specific SNPs as tools for uncovering mixed genetic heritage in captive guenons, and predict they will likewise be valuable methods for detecting introgression in wild populations.

#### Earliest radiometric dates for stratified archaeological remains in Greece: the evidence from Kokkinopilos, NW Greece

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The red-bed site of Kokkinopilos is an emblematic and yet also most enigmatic open-air Palaeolithic site in Greece, stimulating controversy ever since its discovery in 1962. While early research raised claims for stratigraphically *in situ* artifacts, later scholars considered the material reworked and of low archaeological value, a theory that was soon to be challenged again by the discovery of *in situ* artifacts, including handaxes. Here we present results of a long-term study including geoarchaeological assessments, geomorphological mapping and luminescence dating. We show that the site preserves an overall undisturbed sedimentary sequence related to an ephemeral lake, marked by paleosols and stratigraphic units with Palaeolithic material that is geologically *in situ* and hence datable. Our research resolves the issues that have been the source of controversy: the depositional environment, stratigraphic integrity,

chronological placement and archaeological potential of the site. Moreover, the delivered luminescence ages demonstrate that the lithic component with bifacial specimens considerably pre-dates the last interglacial and therefore comprises the earliest stratigraphically defined and directly radiometrically-dated archaeological material in Greece. Kokkinopilos has served as a reference site for the interpretation of all other red-bed sites in north-west Greece, therefore our results have significantly wider implications: by analogy to Kokkinopilos, the open-air sites of Epirus should not anymore be considered 'by default' as inscrutable palimpsests with limited archaeological potential; rather, these sites can be excavated and dated. This realization opens up new prospects for future research in Epirus, an area that is the most prolific in Palaeolithic remains in Greece.

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#### Additional Primate Fossils from the Uinta Formation, Uinta Basin, Utah

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With the recovery of new primate specimens from the Uinta Formation, we now have greater insight into the composition of the declining primate diversity of the middle Eocene. From locality WU-18, Gnat-Out-Of-Hell (Uinta B2), maxillary teeth have been recovered (LP3-4; LM2-3) of the utahiin omomyid, *Chipetaia lamporea*, giving us a more complete picture of the upper dentition of this species, previously known from fragmentary specimens. These teeth also provide insight into the maxillary dentition of the utahiin clade, which is only known in *Chipetaia*. Further specimens from WU-26 (Uinta C) include new specimens of a tiny omomyid, cf. *Omomys*, thus potentially extending the biostratigraphic range of this genus from Ui1b to Ui3.

In addition to new dental specimens, new postcrania have been recovered from both WU-18 (complete cuboid of *Chipetaia*) and WU-26 (complete talus of *Mytonius*). The cuboid of *Chipetaia* is the first one recovered from this taxon. It resembles that of other omomyids such as *Ourayia* and *Hemiacodon* in being elongate, and supporting previous interpretations of leaping specializations in this taxon. The talus of *Mytonius* corroborates the differences from *Chipetaia* and *Ourayia* noted previously based on fragmentary fossils, most notably the poorly developed posterior shelf and posterior expansion of the tibial facet. The neck of the new talus resembles other omomyids in being long and straight, suggestive of leaping capabilities. The morphology of the new talus suggests that *Mytonius* relied on leaping as did other

omomyids, but with perhaps less emphasis on vertical clinging than *Ourayia* and *Chipetaia*.

#### A new anthropoid first metatarsal from the early Miocene site of Songhor, Kenya

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Songhor is an early Miocene locality (~20 Ma) in Kenya known for its diverse primate assemblage including a lorisoid (*Progalago songhorensis*) and several catarrhines (*Limnopithecus evansi*, *Kalepithecus songhorensis*, *Proconsul major*, *Rangwapithecus gordonii*). *P. major* is the largest primate at Songhor and *R. gordonii* is the most common taxon. Dentognathic material is relatively abundant and attributable to specific taxa, but postcranial remains from Songhor are few and difficult to allocate. Renewed expeditions have produced more primate postcranial fossils from both the fore- and hind limbs. In this study we describe KNM-SO 31233, a complete left anthropoid first metatarsal (Mt1). We compare this specimen to a large number of extant anthropoids including catarrhines and platyrrhines (n>300), and several fossils attributed to stem catarrhines (*Aegyptopithecus*; *Catopithecus*), Proconsuloids (*Proconsul*; *Afropithecus*), and Pliopithecoids (*Epipliopithecus*). Morphometric data was obtained from 3D surface renderings derived from CT and micro-CT scans. Univariate and multivariate analyses were performed to assess phenetic affinity with the comparative sample. Regression analyses were performed to estimate upper and lower molar dimensions from Mt1 size variables in order to possibly associate this specimen with dental remains found at Songhor. Overall, KNM-SO 31233 is similar in size to Mt1s of *Hyllobates* and *Ateles*, while its morphology is most similar to fossil catarrhines including *Aegyptopithecus*, *Proconsul*, and *Epipliopithecus*. But, compared to all other fossils, KNM-SO 31233 is absolutely and relatively more gracile in all dimensions and has more shaft torsion. Based on its size, it likely can be attributed to *Rangwapithecus*.

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#### Skeletal Age Estimates: A Comparison of Four Methods

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Biological anthropologists routinely use several age estimation methods when examining human skeletons. Some methods are generally believed to produce more accurate and precise estimates than others, where accuracy is defined as a

correlation between the known and estimated ages, and precision is the age interval width. Several aging methods were tested on two skeletal samples each consisting of over 100 skeletons: the Norris Farms prehistoric skeletons from Illinois and the mid-twentieth century Terry Collection. Methods include Transition Analysis (Boldsen et al. 2002), focused on the pubic symphysis, auricular surface and cranial sutures; Lovejoy et al. (1985), based on the auricular surface; and Todd (1920) and Suchey Brooks (1990), targeted on the pubic symphysis. Transition Analysis is shown to be more accurate and precise than other methods when compared with reported ages in the Terry Collection and experience-based estimates for the Norris Farms archaeological specimens. The procedure also proved to be easier to use by an osteologist with only limited experience and results were more consistent than those of the other procedures from one blind trial to the next.

### Introduction

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Humans are born with only about a quarter of the brain size they will have as adults, a state of development reflected in extreme motor immaturity and inability to maintain contact with caretakers without assistance. This state of helplessness requires an inordinate investment of time and energy from parents and others from birth until reproductive maturity. The helplessness of human newborns is a direct product of our evolutionary history, including a number of biological constraints associated with our form of locomotion, our large brains, energetic demands of our fetuses and of our newborns, and extended childhood. This helplessness also confers advantages on a culture-bearing animal like humans in giving us a head start on exposure to the stimulation of our physical, cultural, social and emotional environments. The extremely helpless and highly dependent state of the human infant at birth may have been as important in contributing to human biological and cultural evolution as “man the hunter” and “woman the gatherer.” How and when did such a costly pattern of development evolve and what benefits has it conferred on humans? This symposium will explore the idea that key human characteristics that distinguish us from other primates owe a significant debt to the helpless infant, including, but not limited to, reliance on culture, tools, language, and cooperative parenting.

### Hormonal correlates of male-juvenile interactions in long-tailed macaques (*Macaca fascicularis*)

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The potential role of mammalian males in parental care may very well be one of the most understudied topics in the scientific literature. Although not as frequent as the interest shown by adult females, males in uni-parental species can also express some levels of social interaction with infants and juveniles in their troop. In the present study a troop (n = 45) of semi-free ranging long-tailed macaques (*Macaca fascicularis*) was observed and social interactions recorded *ad libitum*. Fecal samples were retrieved to assess metabolites of cortisol and dehydroepiandrosterone (DHEA) as indices of the hypothalamic-pituitary-adrenal (HPA) axis activity, and testosterone as an index of the hypothalamic-pituitary-gonadal (HPG) axis activation. It was hypothesized that the males that frequently interacted with infants and juveniles would show greater emotional regulation, as measured by higher levels of DHEA and lower levels of cortisol and testosterone. A positive correlation was found between cortisol levels and the amount of time spent engaged in aggressive behavior (r = .778) and grooming (r = .708) other adults in the troop. Regarding juveniles interactions, positive affiliations were negatively correlated with the cortisol levels of adult males (r = -0.737) and positively correlated with their DHEA levels (r = .961). Corroborating previous research demonstrating adaptive modifications in emotional responses as a consequence of adult-infant interactions, the current results extend these findings to the males of a uni-parental primate species.

### Forelimb mechanics during below-branch quadrupedalism in primates: A comparison to above-branch quadrupedalism and bimanual locomotion

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Arm-swinging behavior is found in several primate groups, but the pathway for the evolution of bimanual locomotion remains unclear. During quadrupedal walking the four limbs support the body in compression, but during arm-swinging the limbs are in tension and the forelimbs provide all propulsion and support, necessitating anatomical and behavioral specializations compared to quadrupedalism. It has been proposed that below-branch quadrupedalism might represent an intermediate locomotor mode that facilitated a transition to bimanual movement. To examine this, forelimb mechanics of below-branch quadrupedalism was compared to above-branch quadrupedalism in *Varecia variegata*, *Propithecus coquereli*, *Lemur catta*, and *Daubentonia madagascariensis*, and duty factors, stride lengths, elbow flexion, and effective forelimb lengths were collected from

video records (120 fps) and calculated for each species. Data from these species were compared to data on arm-swinging primates in the literature and from our own previously collected video.

Duty factor and stride length are longer during below-branch walking when compared to above-branch walking (p < 0.001), and similar to that reported for arm-swinging. During below-branch quadrupedalism, the forelimbs remain flexed (87.3°) and are characterized by a “pull-up” late in support phase. A similar pull-up phase has also been reported in ateline and hylobatid primates during arm-swinging. Meanwhile, effective forelimb length is shorter during above (71.6%) and below-branch (67.4%) quadrupedalism than bimanual suspension (89.7%). The hypothesis that the forelimb in below-branch quadrupedalism would have mechanical similarities to arm-swinging is supported, suggesting that below-branch movement with limbs in tension requires similar biomechanical solutions in both quadrupedal and bimanual settings.

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### Energetic costs of testosterone: higher testosterone is associated with greater lean muscle mass and total energetic expenditure among Tsimane forager-horticulturalists

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Testosterone is thought to mediate energetic allocation between reproduction and survival. Energetic deficits from caloric restriction or high pathogen burden lead to rapid down regulation of testosterone production. The anabolic effects of testosterone are well established, increasing lean muscle mass, which results in greater energetic expenditure, though it is unclear if circulating testosterone increases energetic expenditure beyond the role it has in lean muscle mass. Here we examine whether testosterone is associated with higher total daily energy expenditure (TEE kCal/day) as measured by doubly labeled water (DLW) in forty Tsimane forager-horticulturalists practicing a traditional subsistence lifestyle of hunting, foraging and horticulture. Twenty men aged 20-77 (median 47.5) years, and 20 females aged 18-87 (median 48.5) years drank DLW (120 g; 10% H<sub>2</sub><sup>18</sup>O, 6% <sup>2</sup>H<sub>2</sub>O) and provided urine specimens over a nine day period. Average TEE (kCal/day) was calculated from <sup>18</sup>O and <sup>2</sup>H isotope depletion, and testosterone was measured

via enzyme immunoassay in first morning urine samples. Controlling for age, sex, and lean muscle mass, testosterone was positively associated with TEE (Std.  $\beta = 0.28$ ,  $p=0.030$ ). Males showed a stronger association between testosterone and TEE (Std.  $\beta = 0.45$ ,  $p=0.018$ ) than women (Std.  $\beta = 0.01$ ,  $p=0.979$ ), controlling for age and lean muscle mass. These results indicate that energetic costs of a high testosterone phenotype exceed the costs of muscle mass alone, even in lean forager-horticulturalists with relatively low levels of testosterone. Testosterone is an important mediator of many aspects of male physiology beyond muscle mass, including potentially energetically expensive behaviors.

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#### Comparative morphology and molecular genetic analysis of patterns of syphilis of archaeological human remains from museum collections

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The origin of the treponematoses is one of the most controversial problems in the history of infectious disease. A lot of museum collections consist of the paleopathological samples could be used for the morphological and molecular study. Unfortunately for molecular paleopathologists, besides limitations, which are traditional for study of the archaeological remains, the skeletal lesions diagnostic of treponemal disease usually accompany the tertiary stage of the disease; this stage is when the actual pathogen load in the host's body is relatively low. So, the identification of syphilis by molecular analysis is still problematic. The analyzed samples consist of skeletal remains in the paleopathological collections of Institute of Anthropology of the Moscow State University and Museum of Anthropology and Ethnography (St-Petersburg). The skeletal remains of 7 individuals from 4 different sites dated from XVI - XIX AD, were subjected to macroscopic visual examination to identify occurrences of bony alteration of syphilis. In several cases X-ray method was used. The remaining skeletal samples provide a putative presence of syphilis via pathognomonic osseous alterations. A DNA analysis like diagnostic tool was required. DNA was isolated from 4 bone and 3 teeth samples following standard ancient DNA extraction protocols. Specific regions of pathogen genomes for *T. pallidum* were analyzed by PCR and real-time PCR with various sets of specific primers. PCR-

products were identified by sequencing 16S rRNA-genes. All DNA samples except one showed positive results for *T. pallidum*. The comparative results showed that museum patterns can be trustful source for paleogenetic investigation of syphilis.

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#### Muscle functional morphology of comparative primate locomotor modes: Implications for the study of human fossils

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The evolution of primate locomotor strategies is a subject of considerable debate. Bones survive into the fossil record but muscles are critical for producing locomotor behavior. It is therefore essential to understand how muscle anatomy varies with locomotion. This study adds to the critically low sample sizes of previous work, integrating anatomical data with muscle physiology. We hypothesized that muscles requiring high force-generating capacity due to locomotor function would exhibit high PCSA values. Additionally, postural muscles are predicted to have higher proportions of Type I slow-twitch myosin than muscles responsible for short-burst high force actions, which would have more myosin Type II concentration.

We dissected out six appendicular muscles from nine primates, including great apes and monkeys representing a range of locomotor modes. Mass, fascicle length and pennation angle were measured in each muscle to calculate physiological cross-sectional area (PCSA). Furthermore, biopsies from chimpanzee, gorilla, gibbon and grivet muscles were subject to mRNA extraction to assay myosin isoforms.

Results support the myosin type hypothesis. For example, the long head of the triceps brachii expresses higher concentrations of Type I myosin in brachiators (70.5%) than quadrupeds (56.2%). Triceps brachii also exhibits the highest PCSA value in all samples, demonstrating this muscle's importance across species, including brachiators. In contrast, the quadrupeds exhibit both high PCSA values and Type II concentration in the gastrocnemius and the soleus. These results indicate that muscle architecture varies with locomotor mode and that these relationships may be useful for contextualizing activity-dependent changes observed in hominin fossil bone.

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#### Diet, Mobility, and Pathology in Colonial-Period Northern Coastal Peru: Temporal and Site-Specific Variation

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An impressive body of bioarchaeological research has examined processes of population decline, morbidity, and subjugation throughout North America following conquest by Europeans. Comparatively little work has been done studying the same processes in Andean South America, which boasted the largest pre-contact indigenous states in the Western Hemisphere. This study aims to assess biocultural impacts of colonization in Lambayeque, north coastal Peru, by comparing stable isotopic measures of diet and residential mobility, and skeletal pathological conditions, among individuals interred at the Early/Middle Colonial Period (A.D. 1533-1620) Chapel of El Niño Serranito, Eten (CNS; N=76), the Middle/Late Colonial Period (A.D. 1620-1760) Capilla de Santa Maria Magdalena de Eten (CSMME; N=46), and San Pedro de Mórrope (SPM; N=27). The occupation at SPM spans A.D. 1536-1750; however, this sample dates to the Middle/Late Colonial Period.

People from CNS exhibited the highest overall carbonate and collagen  $\delta^{13}C$  values, carbonate  $\delta^{18}O$  values nearly identical to those from SPM, and the lowest frequencies of pathological conditions. Individuals from CSMME exhibit lower overall diet variation, higher mean  $\delta^{13}C$  and  $\delta^{15}N$  values, and lower frequencies of pathological conditions relative to those from contemporaneous SPM. These results suggest subtle, non-uniform dietary shifts between the Early and Late Colonial periods. Comparing  $\delta^{13}C$  and  $\delta^{18}O$  between enamel and bone among CNS and CSMME individuals also suggests varied changes across lifespans. Overall, this study highlights variation in lived experiences and microenvironments over the course of Spanish colonization in Peru, raising new questions in the study of this tumultuous adaptive transition in the Americas.

#### Using Multivariate Adaptive Regression Splines (MARS) to model body mass over time

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Multivariate Adaptive Regression Splines (MARS) is a non-parametric regression that models non-linearities and performs automatic variable selection through stepwise selection. MARS is an extension of, and improvement on, recursive partitioning. The technique uses linear regression between hinges, or knots, which are based on marginal data values; the slopes of these lines as well as the position and number of hinges gives an indication of the rate and timing of changes in body size.

MARS can be used to model both individual growth, and changes in body size during human evolution. MARS provides cross-validated prediction intervals for estimating age from long bone dimensions as well as models growth over time to assess rate of growth and timing of growth spurts. Although the use of MARS in anthropology is relatively novel and has been limited to age at death estimation, the analysis is applicable to human evolution. Specifically, MARS can model body size over time.

The study sample includes 198 fossil specimens for whom body size has been estimated through multivariate calibration. Results demonstrate a decreasing trend in Australopithecine body size plotted over evolutionary time. The best fitting hinge was placed at 2.6 mya, which is where the body size begins to increase. The trend plateaus after the hinge located at 1.0 mya. The results challenge the notion that body size only increased during human evolution.

MARS is a valuable tool in modeling something as complex and nonlinear as body mass, both in individuals and species.

#### Demographic parameters of commingled skeletal samples

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Published studies of commingled skeletons frequently omit demographic information from analysis, citing the inability to age fragmentary, mixed bones. While discrete individuals typically cannot be evaluated from commingled collections, general patterns of age should be considered when comparing two or more samples. This is particularly important for studies assessing pathological conditions or other alterations to the skeleton. Distribution of phase assignments (instead of ages derived from phases) can provide insight into general demographic changes in commingled samples. This technique was applied to skeletal collections from two time periods from the Early Bronze Age site of Bab adh-Dhra', Jordan (ca. 3500-2010 BCE). Aging techniques included cranial suture closure and pubic symphysis and auricular surface changes in adults, as well as metric

examination of subadult femora, occipitals, and ischia. In general, there was no significant difference between Early Bronze IA (3500-3300 BCE) and Early Bronze II-III (3100-2300 BCE) adults. Right auricular surfaces exhibited no difference (Mann-Whitney U=196, n=45, p=0.26), nor did cranial vault suture closure scores (Mann-Whitney U=105.5, n=35, p=0.32). There was a significant difference between measurements of subadult: femoral distal width (right side: Mann-Whitney U=49, n=38, p<0.001), basilar sagittal length (Mann-Whitney U=329.5, n=79, p<0.001), and left ischial width (Mann-Whitney U=55, n=30, p=0.033). The difference in subadults was due to the presence of more perinates and infants in Early Bronze IA. General patterns of age proxies can contribute to our understanding of demography in commingled collections, and should be considered in any bioarchaeological study.

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#### Functional regions of the trunk in chimpanzees and langurs: a comparison of deep back muscles

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The trunk forms the body core; its shape and proportions connect to locomotor posture and behavior. The spine, traditionally divided by vertebral type, anchors a chain of deep back muscles. Together this musculoskeletal system provides integrity and regional movement to the cranium, rib cage, and pelvic girdle, and in monkeys, the tail. Old World monkeys (pronograde) and apes (orthograde) contrast in trunk structure. This study compares the musculature of seven adult chimpanzees (*Pan paniscus*) and langurs (*Semnopithecus entellus*) following methods of dissection after Grand (AJPA 1977). Deep back muscles are removed and weighed by functional region: Cervical - nuchal crest to C7; thoracic - C7 to last rib; lumbar - last rib to top of ilium; sacral - top of ilium to distal sacrum; caudal - base to tip of tail. Mass of each segment is taken as a percentage of total back extensor muscle. Results demonstrate that *P. paniscus* compared to *S. entellus* has more muscle in the cervical (17.6% vs 8.3%), thoracic (42.4% vs 17.0%), and sacral (15.3% vs 9.6%) regions, and similar distribution to the lumbar (24.7% vs 27.9%). In langurs 37.2% muscle goes to the tail. The trunk comparisons reflect differences in locomotion: 60% of deep back muscles support the *P. paniscus* upper body for climbing and hanging. In *S. entellus* 75% of muscle resides in the lumbosacral and caudal regions to support quadrupedal leaping and

running. The results offer additional data for demonstrating differences in functional morphology in orthograde (*Pan*) and pronograde (*S. entellus*) trunks.

#### The origins of the Aegean palatial civilizations from a population genetic perspective

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The present paper investigates the origins of the Aegean pre-palatial civilizations (5<sup>th</sup>-3<sup>rd</sup> millennium BC) by applying cutting-edge methods of molecular biology and population genetics. The term *Aegean Civilizations* refers to the novel human lifeway (agriculture and craft specialization, redistribution systems, intensive trade) that appeared during the end of the Neolithic and the beginning of the Bronze Age in the Aegean. Although many studies exist on archaeological constructions of ethnic and cultural identity on mainland Greece, the Cyclades and Crete, not enough efforts have been made to explore this direction on a population history basis. We have investigated Late, Final Neolithic and Early Bronze Age human skeletons (n=127) from the Aegean using ancient DNA methods, next generation sequencing (NGS) technology and statistical population genetic inferences to i) gather information on diversity, population size, and origin of the pre-palatial Aegean Cultures, ii) to compare them on a genetic basis, in terms of their cultural division (Helladic, Cycladic, Minoan) and iii) to investigate their ancestral/non-ancestral status to the Early and Middle Neolithic farmers from Greece. In addition to mitochondrial DNA genomes, by applying a capture-NGS approach we collected information on functional traits of the early Aegean communities in southeastern Europe. Considering the *International Spirit* that overwhelms the Aegean during the 3<sup>rd</sup> millennium BC, seen by the wide distribution of artifacts, this palaeogenetic approach provides valuable new insights on population structure of the groups involved in the Neolithic-Bronze Age transition and the spread of specific alleles in this part of Europe.

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### A geometric morphometric study of hominin mandibular variation related to speech production

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The uniquely-shaped human tongue facilitates the production of quantal speech sounds that improve speech intelligibility. It is unclear if Neanderthals and other extinct hominins possessed a modern human-like tongue and vocal tract since these soft tissues do not fossilize. In this study, we investigated the size and shape of muscle markings on the inside border of the mandible that are attachment areas for extrinsic muscles of the tongue and oral cavity. We digitized 68 landmarks on mandibles of modern humans, bonobos, chimpanzees, gorillas, orangutans, and fossil hominins, including specimens of *Homo erectus*, archaic *Homo*, Neanderthals, and pre-modern *Homo sapiens*. We used a Microscribe-G2 3D digitizer to collect data from the Field Museum of Natural History and the programs 3D Slicer v. 2.6 and EVAN Toolbox to collect data from computed tomography (CT) scans. A PCA on the full set of Procrustes-aligned landmarks separates modern and fossil hominins from great apes along the 2<sup>nd</sup> PC, with some hominin specimens falling outside the modern human range of variation. However, Neanderthals, other archaic hominins, and early modern *H. sapiens* fall outside the recent modern human range of variation in a PCA on internal landmarks. The orientation of the mylohyoid line distinguishes recent modern *H. sapiens* specimens from other hominins, including early modern *H. sapiens*, suggesting that the tongue may be anchored differently in the oral cavity in the two. These results suggest that tongue and vocal tract shape may have been different in archaic and early modern hominins and recent modern humans.

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### The Shuar Health and Life History Project: Childhood somatic resources, linear growth, and immune function among indigenous Amazonians

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Within challenging environments, somatic resources represent critical reserves of energy that may fuel metabolic processes during times of energetic stress. As such, understanding the role that body fat plays in moderating life history tradeoffs is critical to the study of human biology and phenotypic plasticity. This research investigates the relationship between childhood somatic resources, linear growth, and immune function among the Shuar of Amazonian Ecuador. Repeat measures of anthropometry (including sensitive weekly measures of lower leg length) and dried blood spot C-reactive protein (CRP) concentrations were obtained from 331 children (age 5-12 years) over a period of three months and analyzed using mixed effects models. Preliminary results suggest that no significant main effects exist between measures of variation in body fat and CRP in this sample; however, skinfolds at baseline are positively related to various measures of subsequent short- and long-term Shuar growth while change in skinfolds over time is negatively related to contemporaneous 3-month ( $p = 0.03$ ) and weekly ( $p < 0.01$ ) linear growth. Although all children were less likely to experience weekly growth when possessing elevated CRP levels (CRP  $\geq 1.0$  mg/L,  $p = 0.02$ ), children with low skinfold values were 7.27 times less likely to grow during times of CRP elevation than children with high skinfold values ( $p = 0.03$ ). These preliminary results highlight the utility of incorporating body fat analyses into studies of childhood ecology. The role of body fat in moderating tradeoffs between immune function and growth is further explored using additional biomarkers.

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### Carbon and oxygen isotope ratios discriminate coastal and inland tropical foragers

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The coastal colonization hypothesis for the peopling of Southeast Asia predicts the exploitation of marine resources, but direct evidence of coastal foraging is scarce > 50 kya. Stable isotope analysis of skeletal remains could be used to infer the utilization of coastal resources. However, this application faces practical challenges at tropical latitudes. For example, a diet of marine protein is often associated with elevated collagen  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values, but collagen is seldom preserved in the

humid archaeological sites of Southeast Asia. The mineral fraction of bone and teeth (bioapatite) is more resistant to diagenesis, but bioapatite  $\delta^{13}\text{C}$  values alone are a crude indicator of coastal subsistence. Here we explore whether measures of  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in hair keratin can discriminate coastal foraging among contemporary peoples. We studied two populations of hunter-gatherers that rely on coastal resources to different extents: the Batek (sampled in 1913 and 1976) and Agta (sampled in 2010). We corrected for temporal variation in atmospheric carbon (to 2010) and used multivariate ANOVA and an approximate multivariate  $F$  test, Pillai's trace. We detected differences ( $F$  value = 19.44;  $P < 0.0001$ ) between coastal Agta ( $\delta^{13}\text{C} = -20.81 \pm 1.24$ ;  $\delta^{18}\text{O} = 12.48 \pm 0.86$ ;  $n = 33$  people) and non-coastal Agta and Batek ( $\delta^{13}\text{C} = -23.25 \pm 1.91$ ;  $\delta^{18}\text{O} = 11.75 \pm 0.69$ ;  $n = 31$  people), suggesting that the tandem of bioapatite  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  values has the potential to detect signatures of coastal foraging in the archaeological record of Southeast Asia.

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### Partners in research? The complex challenge of engaging Toba/Qom people in human biology studies

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The Chaco Area Reproductive Ecology (C.A.R.E.) Program is celebrating its 17<sup>th</sup> year of working with (note the preposition) indigenous groups in northern Argentina. It has been a long, but rewarding road, marked by several faux pas from which we all learned about each other. In this context, my contribution to this symposium revolves about one theme: engaged researchers. In our experience, this can only be achieved if substantial time and resources are devoted to social interactions that develop a sustained level of trust on both sides. Participating in community events (church gatherings, dances, community kitchens) or visiting individuals outside of the data collection schedule has given us ideas on how to best share our work, both while we are in the field and afterwards, when we come back to share our results. Sustaining a respectful dialog with study participants and their communities involves a time allocation challenge, but incorporating this to our research schedule is a must. For those of us working in developing countries, engaging (with) the community also means confronting issues of poverty, social injustice, and marginalization. Depending on your personality, this may paralyze you or trigger the paternalistic demi-god syndrome, both bringing about undesirable consequences. Our humble attempt at navigating this challenge has been the creation of a local non-profit

organization that supports and fosters education (in a broad sense) in the region where we work. Finally, I would like to contest the exporting of western ideals of informed consent to non-western settings.

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**Cost-based phylogenetically-controlled analysis of signal tradeoffs in primate-dispersed fruits**

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Primates and fruiting plants are involved in complex interactions, with primates relying on fruiting trees as food resources, and fruiting trees relying on primates for seed dispersal. The fruit syndrome hypothesis posits that frugivores should drive the evolution of fruit traits based on disperser sensory ability, behavior, and physiology. We evaluate the fruit syndrome hypothesis by testing whether endemic Malagasy fruits in tropical dry forest (N=57) invest in specific signaling strategies – color and odor – at the expense of one another. We measure fruit color using spectroscopy and quantify fruit odor using volatile organic compound sampling and post-hoc gas chromatography-mass spectrometry. To evaluate potential phylogenetic constraint on these strategies, we test for the presence of a phylogenetic structure among traits using an order-level phylogeny. We demonstrate that plants invest in dichotomous signaling strategies according to two different disperser guilds: olfactorily-oriented foragers, and visually-oriented foragers. Plants invest in color signals at the expense of odor, and plants that invest in color signals do so at the expense of odor, producing the mostly costly color – but that which is the only visually conspicuous color to all seed dispersing animals in the study system – blue. Our research provides partial support for the hypothesis that frugivores drive the evolution of fruiting plants – while there is no evidence that plants are producing specialized signals based on one disperser sensory phenotype, there is evidence that primate-dispersed plants in this system are investing in one of two signaling systems: olfactory or chromatic signals.

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**Social and ecological factors mediating female participation in collective action in black howler monkeys (*Alouatta pigra*)**

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Collective group defense can provide benefits to both participants and free-riding group members. Analyzing individual strategies during collective action is thus useful for understanding the evolution and nature of cooperation in animal societies. In many societies, males are the primary participants during group defense, while females participate occasionally. I examine social and ecological factors influencing the participation of adult black howler females (N=13) in naturally occurring howling bouts of five groups at Palenque National Park, Mexico during a 28-month study. For each howling bout, I recorded each female's participation (i.e., howling) at 1-min intervals, and calculated the percentage of scans each female participated. Analyses included only bouts (N=287) for which all females were in view  $\geq 80\%$  of the scans. At least one female was observed to participate in 53% of the howling bouts. The mean percentage of scans that females participated ranged between 9.7 and 28.4%. GLMM analyses revealed that female participation was significantly greater during howling bouts that were part of intergroup encounters compared to spontaneous calls or calls in response to nearby calls ( $F_{2, 277.3}=28.2$ ,  $P<0.001$ ). Female participation was not influenced by the presence of infants vulnerable to infanticide ( $F_{1, 194.5}=3.3$ ,  $P=0.073$ ) or by the proximity to food resources consumed that day ( $F_{1, 281.2}=0.1$ ,  $P=0.924$ ). In four of the five study groups, one female howled significantly more than the other resident female(s) ( $P<0.05$ ), suggesting that these females played a special role within the group's social dynamics, not previously recognized for this species.

*I was supported by a postdoctoral fellowship from Universidad Nacional Autónoma de México during the study.*

**Distinguishing among polygynandrous species based on the relative intensity of pre- vs. post-copulatory, male-male competition: a multivariate approach**

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Morphological characters such as sexual size dimorphism (SSD), residual testes weight (RTW) and sperm midpiece volume (MPV) differ among species and between groups of species with similar mating systems. However, because species-specific intensities of pre- and post-copulatory, male-male competition are difficult to quantify and mating system categories are

broad, hypotheses of sexual selection are difficult to test. We used principal components analysis (PCA) to reduce the dimensions of a morphological dataset and create a 2-dimensional morphospace. We analyzed a correlation matrix of data on RTW, MPV and three measures of SSD for 27 species. Species' PC scores were plotted on a bivariate graph. The first two PCs accounted for 80.13% of variance in the dataset (48.48% and 31.65%, respectively). PC1 correlated with SSD traits, and PC2 with MPV and RTW. We calculated the area of the convex hull of species' positions in morphospace and asked whether species clustered more tightly by mating system or phylogeny. We then compared mean PC1 and mean PC2 values between mating systems using ANOVA. Species clustered more closely when grouped by mating system than when grouped by phylogeny and mean PC values differed between mating systems ( $p < 0.005$ ). In post-hoc analysis, we separated polygynandrous species above the fourth quintile of PC1 from those below, which tightened clustering by both measures. These results suggest reproductive skew may be highest in strongly dimorphic, polygynandrous primates. Further, variation in the intensity of precopulatory competition is an important driver of phenotypic diversity in polygynandrous primates.

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**Comparative ranging patterns of sympatric langurs in a dry forest in Sri Lanka**

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Since animal movement couples organisms to their environment, the study of ranging behavior may provide valuable insights into how organisms interact with their environment and also identify behavioral differences that may facilitate the coexistence of sympatric species. From July 2008 to June 2009, I collected data from two groups of *Semnopithecus entellus* (groups A and B) and one group of endemic *Semnopithecus vetulus* at the Kaludiyapokuna Forest Reserve in Sri Lanka. The home ranges of groups A and B and *S. vetulus* were 9.4 ha, 7.8 ha and 11.1 ha respectively. Home range overlap between group A and *S. vetulus* was 6.1 ha, while overlap between groups A and B was 1.8 ha. The mean day range for groups A and B and *S. vetulus* were 441 m (SD  $\pm$  123), 348 m (SD  $\pm$  135) and 251 m (SD  $\pm$  123) respectively. Both species also displayed directional persistence in their ranging behavior. While, the ranging behavior of group A was negatively correlated with fruit availability, the behavior of group B and *S. vetulus* was not associated with food resource availability. The defendability index (*D*) was also higher for groups A (1.3) and B (1.1) than for *S. vetulus* (0.6). In this study, the



primates differed in several aspects of their ranging behavior, which probably minimized direct contact between species and reduced the potential for ecological competition. This study also revealed that there is considerable inter and intra-specific variation in how these primates respond to changes in resource availability.

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#### **Can the sex of hominin pelvic fossils be assessed using methods developed for recent humans?**

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The most informative way to assess the sex of a recent human skeleton is to examine the pelvis. Anthropologists have developed multiple methods of assessing sex even from a partial pelvis. These methods are often applied to the hominin fossil record to assess or confirm the sex of an individual, under the assumption that fossil taxa had pelves that were sexually dimorphic in the same ways as recent human pelves. However, given the vast differences in pelvic morphology seen in the fossil record, and the different hypothesized selective pressures causing that morphology in different taxa, this assumption is worrisome.

I seek to clarify how fossil hominins are and are not sexually dimorphic in the pelvis to determine which methods of sex assessment can be reliably used with fossil materials. I test the null hypothesis that there is no difference between male and female hominin pelvic fossils for features that are sexually dimorphic in humans today. I consider pelvic evidence from *Australopithecus* and *Homo*. These fossils were assigned to a sex based on body size dimorphism or non-pelvic skeletal elements. The methods of assessing sex developed for recent humans are tested for applicability to the fossil taxa. A method is considered applicable to a fossil taxa if the relevant morphology is preserved on both a male and female and its character differs between the two. This study found that many methods of assessing sex in recent humans cannot be reliably applied to the fossil record.

#### **The Maya Project: Engaging Maya communities and the general public in research through art and multimedia outputs**

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The Maya are the largest living group of Native Americans, with 6-7 million members dispersed across what is now Guatemala, Mexico, and Belize. Their present social and health situation bears little resemblance to their ancient origins when their ancestors, highly skilled in mathematics, architecture and astrology, dominated large areas of the Americas. During 2012 popular interest in the Maya has increased largely as the result of a prophecy, falsely interpreted, claiming that cataclysmic events will occur as a consequence of the end of a cycle within the Maya Long Count calendar. However, in reality, most people do not know who the Maya were and are today. Many even think that the Maya are extinct.

Loughborough University scholars, working together Mexican academics and artists, many Maya themselves, created the [mayaproject.org.uk](http://mayaproject.org.uk) to produce and disseminate high quality research focused on the living Maya; to produce social, scientific and academic multimedia outputs about the contemporary Maya; to work with the Maya by tailoring research questions to their needs; to work with the Maya to provide methods, tools, techniques and concepts for initiatives that are oriented to the improvement of their quality of life; to disseminate science through art and to publicise the work of Maya artists, photographers, researchers and communities in general. To date, the Maya Project has produced five international museum exhibitions, delivered many public lectures, conducted workshops with schoolchildren in the UK and Portugal and published a book.

#### **Correlation of long bone growth and dental development in Medieval Austria**

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Elucidation of three main issues was the aim of our growth study: *i)* establish site-related age estimation functions for long bone dimensions, *ii)* reveal potential growth retardations of subadults, *iii)* determine possible correlations of growth interference with the occurrence of Harris lines (HLs).

A selection of 200 medieval skeletons from the total of 1800 subadult inhumations from a cemetery at the Cathedral Square at St. Pölten (Lower Austria) was analyzed: Four dimensions of each long bone (*A* diaphyseal length, *B* maximum distal metaphysis breadth, *C* diameter

and *D* circumference at midshaft) were measured. The dental age was estimated using x-rays of the jaws. The general stature was calculated and HL statuses were verified by x-rays of the Tibia.

Highly significant correlations ( $p \leq 0.001$ ) were observed for bone dimensions. Quadratic regression models between dental age and bone dimensions resulted in more accurate functions than linear models. Not surprising, the heights of former individuals were consistently smaller than those of today's. To address the issue regarding growth dynamics in mediaeval versus modern times, a simulation of analogical growth dynamics by transforming mediaeval data into modern WHO growth charts was performed. Results of this experiment display no significant growth retardation for the investigated subadults. Although HLs were observed in 50% of the investigated individuals, a statistical significant correlation with possible growth deficiency was not assessed ( $p = 0.113$ ).

We assume that the approved long bone regression formulas are not biased by the selected subsample and definitely valid for reliable age estimation of subadults from medieval St. Pölten.

#### **Social reorganization and biological change: an examination of stature variation among Iron Age Samnites from Abruzzo, Italy**

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Between the Orientalizing-Archaic (c. 800-500 BC) and Hellenistic periods (400-27 BC) of the Iron Age, Samnites shifted from being warlike mountain dwellers to becoming a federate state able to challenge Rome's supremacy over the Italian peninsula. This transition involved a profound reorganization of power relations in the society, which likely affected human biology in many ways. This study explored the biological impacts of this profound social reorganization by examining variation in limb bone lengths (humerus, femur, tibia) and adult stature in relation to time period, sex and social status (as inferred from archaeological evidence). Materials included 568 (192 female; 376 male) Samnites from three different time periods, respectively before, during, and after the social transition. We identified the best regression method for stature estimation in this sample by means of delta of Gini, estimated sexual dimorphism by time period, and used non-parametric analyses to test for differences in long bone lengths and stature among period and status subsamples. Contrary to expectations, results

showed no decrease in bone lengths or stature associated with demographic growth and urbanization in Hellenistic period. Significant differences ( $p=0.02$ ) associated with social status were detected among Orientalizing-Archaic males, where higher status individuals exhibited longer femora and greater stature. Contrary to expectations, in Hellenistic times inequalities appear to be mitigated. Variation in sexual dimorphism throughout social transition and no association between status and female growth outcomes in any period suggest differential access to resources by gender and/or sex-related differences in the susceptibility to environmental perturbations during development.

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#### Measures of dental relief: testing error, testing efficacy

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Measures of dental relief, calculated as the relationship between the two-dimensional (2D) planometric surface area of a molar crown (derived from the crown outline), and the three-dimensional (3D) area of the crown, have been employed to examine dental function. Researchers have argued that relief is correlated with the consumption of structural carbohydrates, such that folivorous and insectivorous primates tend to have greater relief than animals consuming more easily processed foods.

With an increasing availability of datasets from multiple observers, we set out to test the error rates in dental relief calculations in a sample of anthropoids. We examined rates of intra- and interobserver error, error across different methods for calculating 3D surface area, including measuring the tooth crown above the cemento-enamel junction and the crown portion above the lowest point in the basin, and we systematically tested methods for calculating 2D planometric surface area. Finally, we also explored error arising out of software differences.

In calculating 3D surface area, intra- and interobserver error rates were low (1% or below), however the 2D surface area calculations were a major source of error. The tooth crown's tilt when the 2D image was produced could result in an area differences as high as 5%. Additionally, calculating 2D area with ImageJ was more inconsistent than with other software. Moving forward, we recommend standardizing collecting procedures across studies, particularly in reference to tooth orientation – placing the tooth

generally in “occlusal position” is not enough to minimize error for 2D measures.

#### The influence of cranial and postcranial integration on the evolution of hominin basicranial morphology

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Hominins are characterized by a shift towards bipedalism, increased brain size, and a diversity of dietary specializations that may include both morphological (e.g. the enlarged masticatory apparatus of *Paranthropus*) and behavioral (e.g. tool use) adaptations. While ecological change has long been linked to change in both cranial and postcranial morphology, the interactions between these anatomical regions remain difficult to interpret. To determine whether postcranial morphology may have constrained the evolution of cranial form, I tested the hypothesis that important cranial morphologies are linked to postcranial morphology, approximated using the atlas and axis vertebrae. Linear and 3D measurements from a sample of recent humans and chimpanzees ( $n=103$ ) were analyzed using two-block partial least squares, providing RV coefficients (a general measure of correlation). Preliminary results indicate that the basicranium is correlated with postcranial morphology (humans only  $RV=0.2394$ ,  $p=0.004$ ) but the strength of this relationship may be greater in chimpanzees (combined  $RV=0.6175$ ,  $p<0.0001$ ), despite similar overall levels of morphological variation in the two taxa. Additionally, consistent with previous work, lateral structures of the human basicranium appear more weakly correlated with postcranial morphology than midline structures ( $RV=0.0834-0.1321$ ,  $p>0.05$  versus  $RV=0.1264-0.1662$ ,  $p<0.05$ , respectively), suggesting the lateral basicranium is less constrained in humans than in other apes. These results may suggest that hominin crania were able to evolve fairly independently of the postcranium, resulting in a greater range of morphological diversity than in other apes. A possible source of this independence may be the adoption of bipedalism, which also resulted in reduced integration in the thorax.

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#### Estimating the relative abundance of Pliocene hominins in eastern Africa: implications for species distributions

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Our current knowledge of mid-Pliocene hominin diversity indicates that several species shared the landscape in Africa circa 3.4 Ma. However, the ecological niche of each species is poorly known and the distribution and abundance of these species has not been examined quantitatively across sites. For example, *Australopithecus afarensis* has been found to be relatively rare in Tanzania, but there is little information on how its abundance varies relative to other fauna at sites in Ethiopia and Kenya. To address this paucity of knowledge, we analyzed hominin abundance at Hadar, Ethiopia, and East and West Turkana, Kenya. Specimen counts were derived from the Hadar and Turkana databases ( $n=153$  in Hadar,  $n=85$  in East Turkana, and  $n=102$  in West Turkana). To control for taphonomic differences among the sites, we calculated chi-square tests to determine how each site differed from the expected distribution based on the skeletal composition of the examined taxa. Using the minimum number of elements (MNE), the three most common elements per site for *Australopithecus*, *Kenyanthropus*, and the similarly sized cercopithecoid, *Theropithecus*, were determined and the ratio of hominins to *Theropithecus* was calculated. Chi-square tests indicated different taphonomic biases at each site ( $p < 0.001$ ), where different elements predominated due to differences, such as the depositional environment. Hominins were relatively most abundant at Hadar (38%), slightly less common at West Turkana (27%), and East Turkana had the smallest proportion of all samples (11%). We also address possible causes of variation in hominin distributions, such as ecological differences among sites.

#### Facing the facts: Foods versus fists. A test of the Carrier and Morgan adaptive model for early hominin cranial structure

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Carrier and Morgan (2014, *Biol. Rev.*) have proposed an evolutionary model under which selection for the ability to resist damage caused by strikes to the head during fighting may have shaped many of the craniofacial differences between early hominins and apes. While the importance of fighting on the evolution of cranial shape is difficult to quantify, modern analogs do exist for characterizing the cranial structure of taxa that regularly endure sudden impacts to the skull (e.g. bovids). Using this comparative dataset to inform our analyses, we examine two types of data to assess structural changes in early

hominins relative to apes: computed tomography (CT) images and mechanical strain data. We use CT data to examine the distribution of trabecular bone and sinuses in locations hypothesized to be adaptations to resist blows. Bone strain data are used to assess force propagation and dissipation in the face.

Our results indicate that non-robust australopith crania are generally similar to chimpanzee crania in the distribution of trabecular bone and sinuses, and strain dissipation. The primary difference was found when examining robust australopiths, in which the face is heavily pneumatized. Under the Carrier and Morgan hypothesis, the differences would be expected to relate to differences in male competition, and should be reflected in an increased level of sexual dimorphism. However, the robust taxa are not more dimorphic than *Australopithecus afarensis*, which suggests that the differences are were not the result of selection for advantages during combat.

#### Does food preference impact oral processing in non-human primates?

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Non-human primates demonstrate food preferences similar to humans. We have little insight, however, into how preference impacts oral processing in primates. To begin describing this relationship and its potential evolutionary implications for primate feeding, we measured food preference in two tufted capuchins (*Cebus apella*) and compared preferences to physiological variables during chewing of these foods.

Food preference was assessed for each monkey across 12 foods, including monkey biscuits, fruits, vegetables and nuts. Each individual was allowed to choose from all pairwise combinations of foods. Based on pairwise preferences, a ranked scale was generated among the 12 foods. Contemporaneous with preference testing, chewing rate and electromyographic (EMG) activity were measured for the jaw-closing muscles to assess oral physiology during chewing of these foods.

As expected, oral physiology varied with food material properties (FMPs). Here we concentrate on the comparisons of preferred dates and prunes to non-preferred apricots (ductile foods) and preferred almonds versus non-preferred monkey chow (brittle foods) to help control for FMPs. The two capuchins chewed non-preferred

apricots significantly faster than preferred dates and prunes. Alternatively, the two animals showed opposite trends for brittle foods with one chewing preferred almonds significantly faster than monkey chow and the other showing the reverse pattern. Jaw-muscle EMGs showed individual-specific differences in ductile and brittle food comparisons. Although preliminary, these results suggest that food preference may influence oral physiology in non-human primates and provide an evolutionary foundation for a link between food liking and oral processing in humans.

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#### The dispersal of Modern Humans in Asia: the Northern Route Revisited

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The emergence of full-fledged Upper Paleolithic traditions is often regarded as a proxy for the first appearance of Anatomically Modern Humans (AMH) in Europe. Alternatively, Initial Upper Paleolithic (IUP) assemblages, e.g. the Emirean/Bohunician technocomplex could represent pioneer AMH migrations into Europe. Human groups would take advantage of the Greenland Interstadial 12 (GI 12) temperate climate to partly fill the "demographic vacuum" left by the preceding Heinrich 5 cold period.

In Asia, a single dispersal along the southern route is unlikely to account for the diversity of the fossil and/or archeological record. Instead, several routes, multiple dispersal or other mechanisms such as gene flow could be considered. The recent discovery of a 45 000 year old femur from Ust'-Ishim, Western Siberia, confirms that modern humans were half way between the Urals and the Altai during GI 12. Chronologically, it coincides with the appearance of the Asian counterpart of the Emireo-Bohunician, the Northeast Asian IUP, documented between the Altai and Mongolia. The disappearance of this technocomplex around the Heinrich 4 event is consistent with the genetic data showing that the UI individual was close to the common ancestor of present-day European and Asian populations but did not have direct descendants among current populations.

All in all, the data presented suggest that AMH dispersed in Northern Asia prior to the appearance of a full-fledged Upper Palaeolithic. This could represent an unsuccessful pioneer radiation predating the definitive colonization of Eurasia, reinforcing the significance of the

Eurasian steppe belt to modern human expansions into Asia.

#### Functional/adaptive implications of the metacarpophalangeal joint in primates and their relatives

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Previous research has shown that the angle of the proximal surface of the proximal phalanx discriminates between cercopithecoids, which utilize hyper-extended digit postures during quadrupedal locomotion and hominoids, which use flexed digits in prehensile grasping. This study expands upon that research by applying a similar methodology to examine whether this relationship holds among other extant primates and their extant euarchontan relatives. The primary data for this study is the angle of orientation of the proximal surface relative to the shaft of the proximal phalanx. Landmarks used to calculate our measurements were placed on microCT scan-generated, 3D models of phalanges. When applied to the fossil record, these data may help to characterize in more detail the evolutionary shift away from claw-clinging and towards prehensile grasping during euprimate origins. We predict that species utilizing claw-clinging have a lower angle of orientation than those that utilize prehensile grasping, because the former group typically have more hyper-extended metacarpophalangeal joints.

Our results indicate that extant claw-clinging euarchontans (*Cynocephalus* and *Tupaia*) exhibit the lowest angles of orientation while our arboreal grasping strepsirrhine samples had on average a much higher angle of orientation. With regards to our fossil samples, though plesiadapiforms have claws, they appear to have higher angles than extant claw-clingers, while *Notharctus* and *Adapis* exhibit values close to extant strepsirrhines. This may suggest that despite the presence of claws, plesiadapiforms relied on prehensile grasping more frequently than living non-primate euarchontans.

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#### Coping with a challenging environment: nutritional balancing, health, and energetics in wild Bornean orangutans

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## AAPA Abstracts

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The peatland forests of Borneo are characterized by overall low and unpredictable fruit production. Previous work at the Tuanan Orangutan Research Station (TORP) in Central Kalimantan has demonstrated that orangutans prefer fruit and fallback on low energy foods during episodes of fruit scarcity. However, we have little understanding of how they balance and prioritize nutrients in relation to fruit availability, and how macronutrient intake influences orangutan physiology. Because orangutans are frugivores, we hypothesized they would more tightly maintain their target intake of protein (P) than non-protein energy (nPe) when ecologically constrained to eat an imbalanced diet ("protein prioritization"). We used right-angle mixture triangles to examine the relationships among physiological indicators of energetic status, health, and macronutrient intake during episodes of fruit scarcity. Data were compiled from 2,233 full-day focal follows on 49 habituated orangutans (*Pongo pygmaeus wurmbii*) totaling over 39,000 hours of observations. We found a negative relationship between fruit availability and the P:nPe ratio ( $p < 0.05$ ), and P intake was maintained more tightly than non-protein intake, a pattern that is consistent with protein prioritization. Orangutans at Tuanan frequently fell into a negative energy balance state, as evidenced by urinary ketone production, and lower levels of C-peptides, particularly when nPe intake was low. However, orangutans maintained a stable nitrogen balance state, as evidenced by urea concentration,  $\delta^{15}\text{N}$  values, and 3-MH. Preliminary analyses suggest that the link between immune function, as quantified by cytokine concentration, and caloric intake is complex and requires further examination.

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#### Multivariate cranial affinity of Paleoamerican crania from Lagoa Santa, Brazil in comparative global context: A 3D geometric morphometric analysis

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Buffalo, SUNY, <sup>2</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>3</sup>Department of Anthropology, The Ohio State University, <sup>4</sup>Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica del Norte.

The nature and timing of the first peopling of the Americas is subject to considerable debate. One of the key contributions to this debate is the observation that the cranial shape of the earliest dated "Paleoamerican" remains differ morphologically from more recent Native Americans, which closely resemble modern East Asian populations. Previous studies of linear dimensions showed that earlier Paleoamerican remains resemble present-day Australasian populations, which suggests strong morphological changes across time in the Americas. However, no consensus model exists to explain the origin if this diachronic diversity, which has been suggested to be the result of two distinctive migrations or a single migration into the continent, combined with either genetic drift, adaptation, and/or recurrent gene-flow with Asia. Here we present a 3D geometric morphometric analysis of several series of Paleoamerican remains from the Lagoa Santa region, Minas Gerais, Brazil, within the comparative context of globally distributed populations. Configurations comprising over 150 craniofacial landmarks were collated by a single observer for all populations tested. Principal Component Analyses substantiate a large degree of variability among New World populations. Lagoa Santa specimens lie at the edges of the distribution comprising New World and Asian populations, and overlap with specimens from Sub-Saharan Africa and Australasia. These analyses suggest a complex pattern of cranial affinity with Paleoamerican populations sharing some cranial features with other Asian and New World population, yet also resembling African and Australasian populations in cranial shape, allowing us to reassess the debates surrounding the origins of observed Native American morphological diversity.

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#### Leadership in an egalitarian human society

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Leadership is instrumental to resolution of human collective action dilemmas, particularly in large, heterogeneous groups. Less is known about the characteristics or effectiveness of leadership in small-scale, homogeneous and relatively egalitarian societies, in which humans

have spent most of our existence. Among Tsimane' forager-horticulturalists of Bolivia, we (1) assess traits of leaders under experimental and naturalistic conditions, and (2) test whether leaders impact collective action outcomes. We find that leaders are physically strong and have more kin and other exchange partners. Their ranks on physical dominance, kin support, and trustworthiness predict how well their groups perform, but only where group members have a history of collaborative interaction. Leaders do not take more of the spoils. We discuss why physically strong leaders can be compatible with egalitarianism, and we suggest that leaders in egalitarian societies may be more motivated by maintaining an altruistic reputation than by short-term rewards of collective action.

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#### Diagnosis by consensus: Interpreting mummified pathological conditions

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This study demonstrates the difficulties in radiological anthropological studies of mummified remains by focusing on a case of spinal pathology in an ancient Egyptian mummy at the Museo di Anatomia Umana in Pisa. The mummy was CT scanned in 2011 and the scans were contributed to the IMPACT Radiological Mummy Database. In reviewing the scans for another study, several spinal abnormalities, unreported in previous studies of the mummy (Caramella et al., 2007; Giuffra et al., 2009; Caramella et al., 2010) were noted. The challenges in diagnosis of conditions from mummified remains are demonstrated particularly well, here, as some of the same conditions in this mummy were correctly diagnosed by the original researchers in other dry bone materials (Giuffra et al., 2010a,b).

The goal of this study is not to critique the work of previous researchers, but to demonstrate the need for interdisciplinary consensus and the inclusion of mummy radiology specialists in the analysis of mummified remains and in the differential diagnosis of the pathological conditions within them. This process of *diagnosis by consensus* is essential to the analysis of these remains, complexly altered through natural and anthropogenic processes in

the millennia subsequent to the individual's death.

We will discuss the challenges that radiography of mummified soft tissues pose in anthropological analysis and review the osteobiographical and diagnostic aspects of the radiological findings in this mummy. The authors propose a diagnosis of DISH, additional signs of undifferentiated spondyloarthropathy, and lumbarisation of S1.

#### **African American Cemeteries: The Tragedy of Overlooking the Marginalized**

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Within the state of Florida, there are laws in place in order to maintain funerary operations to which the cemetery owners must absolutely comply. However, within the past 30 years in Florida there have been cases of cemetery neglect and improper burial of remains. The broadcast news and newspapers covered these stories, explained the details of the cases and provided follow-up months later. Unfortunately, public awareness of these issues did not seem to carry over to many of the desecrated African American cemeteries within the state.

In 2012, Wade created a Florida GIS database detailing the many African American cemeteries that were abandoned or in some cases removed. Florida Statutes §497.266 and §497.284 were put into place to help regulate the maintenance of cemeteries after they are forgotten. These statutes indicate that the cemetery owner must allocate funds to cover maintenance fees, etc. The question here not only is, who is watching the cemetery owners but also who is making sure these places are properly preserved?

Greenwood cemetery, located in Jacksonville, Florida, came under scrutiny in 1990 when a reporter was informed that there were human bones scattered throughout the property. This presentation discusses the various injustices seen throughout the state through Wade's GIS database as well as the many wrongdoings observed at Greenwood Cemetery. In addition, Wade and Walsh-Haney will explore the lack of oversight at African American cemeteries throughout the state of Florida.

#### **Mitigating health disparities: a human rights imperative and the role of anthropological geneticists**

JENNIFER K. WAGNER. AAAS Congressional Science and Engineering Fellow.

Racial health disparities persist. These disparities are the result of interacting biological, psychological, and social determinants and relate to access, interactions (e.g., diagnosis, management, and treatment), behaviors, and outcome. The continued under-inclusion of minorities in biomedical research--regardless of source causes--creates and perpetuates disparate impacts of genetic and genomic technologies and interferes with the enjoyment of numerous recognized fundamental human rights. Mitigating health disparities is a human rights imperative, as is clear from a review of the core international human rights documents--including the International Convention for the Elimination of All Forms of Racial Discrimination to which the United States became a ratifying party 20 years ago. A brief analysis of the AAPA Code of Ethics in connection with the US government's periodic reports submitted to the United Nations in 2000, 2007, and 2013; the Concluding Observations and Recommendations issued in 2008 and 2014; and the US governmental responses thereto reveals an essential role for anthropological geneticists in the design, implementation, and evaluation of special measures to mitigate racial health disparities. There is an urgent need for anthropological geneticists to engage and educate not only the individuals and communities for whom the research is applicable but also the broader health disparities research community, human rights practitioners, and policymakers. Highlighted resources and recommendations provide pragmatic ways in which anthropological geneticists might responsibly advance our understanding of human diversity and mitigate racial health disparities.

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#### **Female chimpanzees (*Pan troglodytes schweinfurthii*) form social bonds**

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Chimpanzees are characterized as 'non-female-bonded' and relationship strength among females is frequently reported as weak, primarily due to low levels of gregariousness relative to males. However, chimpanzees exhibit considerable behavioral diversity and several studies have reported relatively higher rates of gregariousness and affiliation among females in both East and West Africa populations. Yet despite these reports, the generalization that at least East African chimpanzees are characterized by weak female bonds remains pervasive in the literature. Here I address differential social bonds among female East African chimpanzees at Ngogo, Kibale NP, Uganda. Focal females spent 64% of time associating with other females. Even though association indices were low on average, 35% of

dyads (n = 276) were preferred associates (actively associated significantly more than expected based on a random model of the pairwise affinity index) and 14.5% of all dyads were preferred grooming partners. However, female association patterns were highly differentiated and females formed distinct social cliques -- within the four cliques an average of 90% of dyads were preferred associates and 49% were preferred grooming partners (all but one female had at least one preferred grooming partner). Thus, even based on grooming alone females formed bonds that can be considered friendships. While these relationships can appear weak when compared directly to male relationship strength, they are nonetheless still important to the social structure of chimpanzees. It is important to recognize this level of diversity when making generalizations about the species.

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#### **Variation in Osseous Histological Features in a Sample of Early Twentieth Century Americans**

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Thin sections were prepared from bone plugs from the anterior midshaft right femur from 105 human specimens from the Hamann-Todd Collection of both African (46 males, 27 females) and European (13 males, 19 females) ancestries, aged 18 to 68 years. Sections were x-rayed before mounting for histological study. Primary and secondary osteons, poorly calcified secondary osteons (PCSOSM), and percent of field composed of circumferential lamellar bone were quantified. Intercorrelations between variables, and correlations of these with known age of specimen are examined. It is hypothesized that PSOSM will vary with age, as new secondary osteons are formed. Among males, all variables, except poorly calcified secondary osteons, are found to correlate significantly with age at the .01 level. Among females, only secondary osteons and osteon fragments per sq. mm. correlate with age. However, all four variables correlate significantly with one another among both sexes. No significant difference due to geographic origin is found. Secondary osteons and fragments correlated significantly negatively with primary osteons and poorly calcified osteons. Variables have a nonlinear relationship with age. Those under 30 years of age is significantly different from older age cohorts (ANOVA, p < .05) for all but PCSOSM. Other age cohorts are largely not significantly different for most variables. Sex has no significant effects. Lamellar bone and primary osteons decrease with age, while secondary osteons and fragments increase with age, but PCSOSM appear to be uniformly distributed with age, suggesting a relatively regular rate of new osteon formation throughout life.

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**Male dominance rank and mating success in the ring-tailed lemur (*Lemur catta*)**

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In many species, male-male competition for fertile females determines male mating success. The priority-of-access model predicts male mating success based on male dominance rank, with the highest-ranking group male predicted to monopolize matings when estrus is asynchronous. *Lemur catta* is an appropriate species in which to test this model because typically only one female enters estrus at a time in a group, females are known to mate with multiple males, and differing results have been reported for the relationship between male dominance rank and mating success. We tested the prediction that alpha males will monopolize females during their estrous periods, mating and ejaculating with the most females and mating first with females.

Observations of mating behaviour and dominance interactions were recorded for four wild, free-ranging groups of *L. catta* at Berenty Reserve, Madagascar during three mating seasons. Each year was analyzed separately. We found that male rank was positively correlated with ejaculations and mate order. We found no relationship between male dominance rank and number of copulatory partners. Our findings do not support the predictions of the priority-of-access model (that high ranking males will achieve higher mating success, as measured by number of copulatory partners). This result may be due to the fact that estrus *L. catta* females tend to mate with each unrelated male in the group. When mating success is measured by mating order and number of ejaculations, however, the alpha males we studied had the greatest mating success.

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**Costlier inside or outside? The costs of baby carrying from pregnancy to weaning**

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How are we to understand the costs of reproduction from the perspective of the mother? Clearly there is a substantial energetic burden just for 'building' a human *in utero*, but the mother additionally has to do a variety of other tasks, including foraging and other mobility-orientated behaviors, during the gestation and lactation periods. Thus, the cost of reproduction

includes not just the costs of gestation and lactation, but the additional costs of morphology shifts (i.e. during gestation) and simultaneous burden carrying (e.g. gestation and post-partum baby carrying). Here, data are presented on women (N=5) walking during pregnancy and also while carrying their infants for six months post-partum. During pregnancy, women's energetically optimal walking speeds increase until the very end of the 3<sup>rd</sup> trimester (3-5% increase, followed by a 5% decrease,  $p=0.034$ ), but the optimal speed rebounds dramatically post-partum (6% faster than 3<sup>rd</sup> trimester). While unloaded walking remains substantially faster, carrying the infant post-partum is more energetically costly (2%), and entails a slower walking speed (4.6%) than during the 3<sup>rd</sup> trimester. This trend continues from one to six months post-partum, and is exacerbated during arm carrying rather than sling carrying (17% more costly in arms). Morphologically speaking, women with an absolutely wider bi-trochanteric width have a significantly faster optimal walking speed ( $p=0.039$ ,  $R^2 = 80.3\%$ ) while carrying, thus offsetting some of these mobility costs.

**Skeletal effects of physical activity differ between populations**

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The effects of physical activity on skeletal structure and strength are frequently observed to vary from one individual to the next. Here, we examine whether such variation also exists at the population level. An experiment was conducted involving mice from two outbred stocks that have been reproductively isolated for >100 generations (Hsd:ICR, Crl:CD1). Growing females from each stock were either treated with a treadmill-running regimen for 1 month or served as controls. Home-cage activity of all animals was monitored during the experiment. Limb forces were recorded to verify that they were similar in the two stocks. After the experiment, micro-CT was used to quantify cortical and trabecular bone structure in the tibial mid-diaphysis and proximal metaphysis, respectively, and mechanical testing was used to determine diaphyseal strength. Among Hsd:ICR mice, running led to significant improvements in diaphyseal bone quantity, structural geometry, and mechanical strength, as well as enhanced trabecular bone morphology. In contrast, among Crl:CD1 mice, the same running regimen had little effect on tibial structure and strength. In neither stock was body mass, muscle mass, or cage activity different between runners and controls. Given that most environmental variables were controlled in the study, we suggest that the differential effects of exercise on the bones of Hsd:ICR and Crl:CD1 mice were due to genetic differences between stocks. Based on these results, when analyzing skeletal

structure among past humans, it should be kept in mind that the 'functional signal' in bones from different populations could vary despite similar activity patterns during life.

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**Cannibalism vs funerary defleshing and disarticulation after a period of decay: micro-morphometric comparisons of cut-marks on human and non-human remains from four prehistoric sites**

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Cut-marks are produced when a knife (of flint, metal etc.) strikes the surface of a bone. Cut-marked human remains are surprisingly common in prehistoric contexts. Ascertaining the interval between an organism's death and the production of cut-marks often remains uncertain, relying on indirect evidence. New 3-Dimensional technology (the Alicona InfiniteFocus Microscope) enables micro-morphometric characteristics of cut-marks to be quantified. This paper presents research that aims to determine whether cut-marks on a fresh corpse leave different micro-morphometric traces than those occurring after a period of decomposition. Cut-marks on human and non-human remains from four prehistoric sites have been analysed: the British Upper Palaeolithic (~14,700 cal BP) site of Gough's Cave, interpreted as cannibalism, and the Serbian Mesolithic-Neolithic sites (~9,500-5,500 BC) of Padina, Vlasac and Lepenski Vir interpreted as funerary defleshing and disarticulation after a period of decay. Results have shown that the micro-morphology of cut-marks on human and non-human remains at Gough's Cave are similar and relate to specific butchery tasks. The micro-metrics, however, are different, probably due to differences in body size. At the three Serbian sites, both the micro-morphology and micro-metrics of cut-marks on human and non-humans remains differ, suggesting that the human remains were not butchered or fresh when cut. This pilot study suggests that micro-morphometric characteristics of cut-marks can be used to infer past funerary behaviour, and it would be valuable to increase the size of this data-set.

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**Biomechanical Analyses of Femoral Robusticity at Paquime, Chihuahua, Mexico**

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Biomechanical analyses of long bones have frequently been used to infer behavioral differences amongst and between human populations. In particular, these analyses have been effectively used to examine differences in general patterns of physical activity during periods of subsistence and cultural change. In this study, we use cross-sectional geometry from a sample (N=45) of previously sectioned mid-shaft from the site of Paquime, a large, sedentary agricultural population in northwestern Chihuahua, Mexico. We compare them to other foraging and farming groups throughout Mesoamerica and the American Southwest to examine patterns of variability in femoral diaphyseal robusticity. To examine these patterns, body mass-standardized measures of bending rigidity (I), polar second moments of area (J), and diaphyseal shape ratios ( $I_{max}/I_{min}$ ) were used. The results of *t*-tests suggest that Paquime differs from other sedentary agricultural populations in loading history. Secondly, *t*-tests and coefficients of variation (CV) were compared between males and females, and appear to support previous hypotheses of declining sexual dimorphism with the transition to agriculture. The results are discussed in terms of the consequences of sedentism and population aggregation, and the rugged, mountainous resource catchment areas available to the inhabitants of Paquime.

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#### Local people and the ethics and economics of habituating primates

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To a large degree, the welfare of non-human primates (NHP) rests with the people who live near them. Unfortunately in many cases, economic conditions force people and NHP to compete for space and other resources where humans are at a decided advantage. Habitat loss, the harvesting of timber and non-timber forest products, and bushmeat hunting are well known threats to NHP populations. Recently, it has been proposed that the habituation of primates may warrant inclusion on this list. More specifically, it has been suggested that the habituation process and the presence of primatologists has the potential to make NHP more susceptible to hunting and capture for the pet trade by diminishing their fear of humans. These concerns are well founded as several examples demonstrate. This paper will look at these concerns while also shining a light on the economic benefits to local people of long-term projects such as employment, the purchase of local goods, and the creation and maintenance of protected areas. Using recent field studies from

the Democratic Republic of the Congo, the results suggest a complex relationship between NHP, local people, and the researchers caught between them.

#### Temporal Survival Analysis of Medieval St. Mary Spital Cemetery, London (c. 1120-1400 CE)

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The rapid increase of population density in urban centers facilitates the transmission of infectious diseases, unsanitary living conditions, and other detrimental factors. The failure of a population to adapt to these changes should be evident in lower rates of survivorship as urbanization increases. Previous bioarchaeological studies investigating health changes linked to urbanization primarily assessed raw frequencies of pathological lesions in urban and rural skeletal collections, interpreting higher levels of pathologies in urban collections as evidence for deteriorating health. This study adds to urban-rural comparisons by investigating survival patterns of individuals from a single medieval London cemetery, St. Mary Spital, dated to the eve of the Early Modern Period when London was undergoing early urbanization. Based on Bayesian radiocarbon dating, the cemetery has been divided into distinct chronological phases, with this study including samples from the three earliest phases, Phase 14 1120-1200 (*n* = 50), Phase 15 1200-1250 (*n* = 53), and Phase 16 1250-1400 (*n* = 45). The results of Kaplan-Meier survival analysis indicate survival differences among these three phases (*p* = .042). Survivorships for Phases 14 and 16 are similar and both are higher than that for Phase 15. Moreover, the 95% confidence intervals for mean survival time of Phases 14 and 16 overlap substantially. These preliminary results might suggest that survivorship does not simply decrease linearly as urbanization intensifies and indicate that research on urbanization should consider factors such as migration, famine, the heterogeneous nature of populations, and the diversity of health environments associated with urbanization.

*Data for this study come from a project funded by the Walker Institution and the Department of Anthropology of the University of South Carolina.*

#### Recognizing rivals: Do female olive baboons (*Papio anubis*) forgo social bonds during periods of heightened competition?

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Bonds between both closely related and unrelated females characterize many primate

species, especially those in multi-male, multi-female social systems. Studies indicate that increased food competition can weaken these bonds. However, there has been decidedly less research devoted to testing whether competition for mating opportunities affects female bonds. To address this question, I consider the impact that female reproductive state and male mate-guarding has on female social relationships in a group of wild olive baboons (*Papio anubis*) at Gombe Stream National Park. Across two study periods, I recorded agonistic and affiliative interactions between focal females (*n* = 20) and all adult individuals in three different troops. I used approach-retreat interactions to determine dominance ranks. Generalized linear mixed models were employed to test for an effect of rank, age, and reproductive history on rates of agonistic and affiliative interactions across different life history periods as well as during the context of male-female consorts. As predicted, while in consort and regardless of their rank, females engaged in fewer affiliative interactions with other females (*n*=1028, SE=0.343, *t*=2.485, *p*=0.024). This is unsurprising given that the presence of a mate-guarding male may limit these interactions. Nevertheless, while in consort, females engaged in higher rates of intrasexual agonistic interactions (*n*=346, SE=0.078, *t*=-2.237, *p*=0.039). These data have important implications for our understanding of female intrasexual competition and aggression, especially in the form of direct competition for mates, and demonstrate that this may be an important mechanism shaping female relationships in olive baboons and potentially across other primate species.

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#### The Mandibles of Castrated Male Rhesus Monkeys (*Macaca mulatta*)

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Studies on the skeleton of castrated male humans and monkeys have generally revealed the failure of the fusion of the epiphyses leading to increased stature, the thinning of the cortical bone in long bones and the skull, high incidence of osteoporosis, and the roundness of the calvarium indicating the importance of

testosterone in skeletal development and bone health maintenance in males, as estrogen is in females. In this study, the effects of orchidectomy on bone and teeth were investigated in mandibular skeletons from castrated male Cayo Santiago rhesus macaques. It was hypothesized that the castrated males would have feminized mandibles and teeth. Comparison of four castrated males to normal adult males and females demonstrated that all four mandibles have overall size comparable to normal males, including canine height. However, there were significant differences between castrated and normal males. In the castrates, [1] the distance between the two rami were narrower than in normal males leading to a relatively narrower and longer face; [2] both mandibular body and ramus had thinner cortical bone leading to less total bone mass; [3] the canines and other teeth were slender. In addition, the two castrates that died at old age had the alveolar bone highly receded with signs of periodontitis in one individual, a condition that was uncommon in normal old males. These differences suggest the importance of testosterone in craniofacial development and health in male macaques.

#### A large 1.5 million-year-old hominin radius from Koobi Fora, Kenya

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A nearly complete hominin radius dated to 1.5 Ma was found in 2008 at Ileret, East Turkana, Kenya (KNM-ER 48100) (Kirera et al 2009). It is unassociated with craniodental remains, and thus its taxonomic attribution has remained uncertain. The OH 80-11 radius from Olduvai Gorge (Dominguez-Rodrigo et al 2013) is securely attributed to *Australopithecus boisei* based on association with teeth, providing a chance to re-evaluate the taxonomic attribution and evolutionary significance of KNM-ER 48100.

KNM-ER 48100 has a head with deep, straight sides, a neck that is relatively round in cross-section, differing from the narrow, beveled radial head margin and compressed neck of OH 80-11, morphologies also seen in the diminutive KNM-ER 1500 specimen often attributed to *A. boisei* as well. This, and its large size, indicate that KNM-ER 48100 is most likely attributable to *Homo erectus*.

The most notable feature of KNM-ER 48100 is its impressive size, with a head diameter overlapping that of female gorillas. Its length is estimated at about 300 mm. This is longer than the radius of almost any human in the

comparative sample, substantially larger than that of the KNM-ER 15000 *Homo erectus* radius, and comparable to the length of the Omo L40-19 ulna. Published stature regression formulas yield stature estimates of over 188 cm. The KNM-ER 48100 radius indicates the presence of very large *Homo erectus* individuals in East Africa around 1.5 Ma, also suggested by a metacarpal from West Turkana and other penecontemporaneous Koobi Fora fossils.

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#### Direct evidence of milk consumption from ancient human dental calculus

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Milk is a major food of global economic importance, and its consumption is regarded as a classic example of gene-culture evolution. Humans have exploited animal milk as a food resource for at least 8500 years, but the origins, spread, and scale of dairying remain poorly understood. Indirect lines of evidence, such as lipid isotopic ratios of pottery residues, faunal mortality profiles, and lactase persistence allele frequencies, provide a partial picture of this process; however, in order to understand how, where, and when humans consumed milk products, it is necessary to link evidence of consumption directly to individuals and their dairy livestock. Here we report the first direct evidence of milk consumption, the whey protein

$\beta$ -lactoglobulin (BLG), preserved in human dental calculus from the Bronze Age (ca. 3000 BCE) to the present day. Using protein tandem mass spectrometry, we demonstrate that BLG is a species-specific biomarker of dairy consumption, and we identify individuals consuming cattle, sheep, and goat milk products in the archaeological record. We then apply this method to human dental calculus from Greenland's medieval Norse colonies, and report a decline of this biomarker leading up to the abandonment of the Norse Greenland colonies in the 15<sup>th</sup> century CE.

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#### The consequence of the global supermarket on the isotope signatures of modern humans

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Modern Americans consume imported foods, foreign beverages, and bottled water. The consumption of these imported products has increased since the rise of the global supermarket. Studies in forensic anthropology suggest the consequence of the global supermarket is the homogenization of biogeochemical signatures in modern humans. For this presentation, radiogenic strontium (<sup>87</sup>Sr/<sup>86</sup>Sr) and stable oxygen ( $\delta^{18}$ O) isotopes were analyzed from modern donated skeletal collections to understand the effects of the global supermarket over time.

Isotopic assays from bone collagen, hair keratin, and enamel apatite from the William Bass, Maxwell Museum, and Texas State University-San Marcos donated skeletal collections were combined with previously reported data from the United States Air Force Academy and Joint POW/MIA Accounting Commands Central Identification Laboratory. Samples from individuals with self-or-family-reported birth locations and/or permanent residential history changes were used for this study. Birth year for the donated individuals ranged from 1903 to 1987. <sup>87</sup>Sr/<sup>86</sup>Sr values (n=75) ranged from (0.70749-0.71324; SD=0.00099) and  $\delta^{18}$ O values (n=95) ranged from (14.35‰-21.47‰; SD=1.48). Spatial and temporal analyses for <sup>87</sup>Sr/<sup>86</sup>Sr and  $\delta^{18}$ O data were conducted using

ArcGIS 10.2, and classified by Jenks natural breaks according to birth year and tested with calibrated probability assignment models.

The  $^{87}\text{Sr}/^{86}\text{Sr}$  results show that modern human isotope signatures gradually approach the value of seawater over time (0.7092). Modern human  $\delta^{18}\text{O}$  isotope signatures remain variable and less dependent on the individual's birth year. The consequence of the global supermarket is its effect on the usefulness of  $^{87}\text{Sr}/^{86}\text{Sr}$  isotopes for individuals born after 1980.

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#### Exploring the effects of constant versus age-specific fertility rates on prehistoric population estimates

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Many fundamental questions about the prehistory of the American Southwest require accurate estimates of population size and other demographic parameters in order to be investigated properly. The Artificial Anasazi model and its successor, Artificial Long House Valley, are agent-based models that use archaeological and environmental data as well as empirically derived demographic estimates to study population dynamics in Long House Valley, Arizona from AD 800 to AD 1300. The Artificial Anasazi model focuses on household-level processes and uses constant demographic rates while the Artificial Long House Valley model focuses on individual-level processes and uses age-specific rates. In the present study, versions of the models described above have been adjusted to remove underlying environmental variation and other confounding variables, which allows in-depth analyses of the consequences of basing population size estimates on constant demographic rates, especially when age-specific rates are available. The original models used what appeared to be mathematically equivalent estimates of total fertility, but the simplified models reveal significant differences in population size estimates for the two fertility schemes (359.67 average individuals (constant fertility) versus 189.34 average individuals (age-specific fertility), over 1000 runs.) Higher fertility in the youngest age group when using a constant fertility rate resulted in increasing disparities in population size estimates over time. Although using constant demographic rates is more tractable when describing population trends for large areas over long spans of time, results such as those presented here highlight the sensitivity of population estimates to

assumptions about the scale at which demographic processes operate.

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#### Mouse models for identifying hybridization in the hominin fossil record: preliminary results

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Hybridization has played an important role in structuring genetic and phenotypic diversity across myriad organisms, including primates. While it is often overlooked as a primary agent in hominin evolution more broadly, the sequencing of the Neanderthal and Denisovan genomes has led to increased acceptance that hybridization occurred between geographically and morphologically distinct later hominins. Although recent research on the phenotypic expression of hybridization has provided important insight into our understanding of variation in the hybrid skeleton, our ability to detect hybrids in the fossil record (and therefore the precise time and place of hybridization) is still limited. Here we use a mouse model to better quantify the range of cranial variation within different hybrid samples, and to examine differences in hybrid phenotypes across these samples. We focus on the house mouse, comparing different subspecific (e.g. *Mus musculus musculus* X *M.m. domesticus*) and specific (*M. musculus* X *M. spretus*) crosses, as well as different types of hybrids (e.g. F1, B1) within each cross. Mice are bred in captivity (N=50/cross).  $\mu\text{CT}$  scans are acquired from these mice following sacrifice, and analysed in Avizo. Preliminary results indicate that hybrid crania are typically extreme in size relative to their parental taxa, and are highly variable in shape, with many individuals outside of the range of parental variation. We also observe maternal effects in some crosses. This study provides important evidence for the prevalence of heterotic and transgressive phenotypes, and illuminates key differences in the expression of these phenotypes, across hybrid groups.

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#### Balancing the body: frontal plane dynamics during locomotion

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Hominin bipedalism creates a unique challenge for balancing the body in the frontal plane during locomotion. Because of the high energetic cost of significant mediolateral displacements of the center of mass and their potential effects on lower extremity injuries, selection to reduce forces in the frontal plane should be high. The shape of the hominin ilia and femoral bicondylar angle are important adaptations for minimizing these forces, yet little is known about the interaction of hip and knee joint mechanics for providing frontal plane stability. Increased thigh adduction angle during stance is predicted to decrease body center of mass displacement and mediolateral ground reaction forces, thus reducing hip and knee abduction moments. To test this model we collected full body kinematics and kinetic data on twenty-three subjects walking and running at preferred, narrow, and wide step widths. As predicted, increased thigh adduction angle decreased mediolateral ground reaction forces and body center of mass displacement in both gaits. However, mediolateral ground reaction force magnitude was weakly correlated with knee and hip moments during locomotion. Instead, knee moments during walking decreased with greater knee valgus, while hip moments were positively correlated with knee abduction moments. During running, both hip and knee moments correlated strongly but independently with shank and thigh adduction angles respectively. These data indicate that mediolateral ground reaction force is less influential than lower-limb kinematics on knee and hip moments during walking and running and the dynamics of each gait have different effects on joint stress.

#### Mapping Migration: Tracing Ancient Human Mobility via Local Bioavailable Strontium Isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) Signatures in the Iberian Peninsula

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In this study we detail the results of research that identifies the proportion of migrants found in burials located near major late prehistoric aggregation centers in Portugal and Spain using radiogenic strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) ratios from human dental enamel. The archaeological record of late prehistoric, socially complex, pre-state level societies of Portugal and Spain suggests that some groups were engaged in a form of chiefly cycling, in which large population centers formed, flourished, and suddenly declined in many parts of the Iberian Peninsula. Though researchers assume that population migration and long distance trade



played an important role in these regional developments, very little is known about specific push-pull movements of people from cores (large-scale aggregation centers) to peripheries (rural agricultural communities, or highlands), and how these mobility patterns played into the transition to intensive agriculture and year-round sedentism. The results of this isotope analysis demonstrate that while the number of migrant individuals at the surveyed sites is quite variable (between 5 and 30%), the identified migrants tend to exhibit  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios that suggest movement from regions with older geologic formations (such as the interior highlands) to geologically younger coastal, estuarine, and riverine settlements, likely indicating that waterways and irrigable agricultural lands were highly valued and attractive locations for resettlement. Tracing inter-settlement mobility more clearly in late prehistory requires the construction of regional maps of bioavailable  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratios. The research presented here lays the foundation for further strontium isotope mapping of human migration in the Iberian Peninsula.

**Age belies reproductive status in a wild population of *Saguinus fuscicollis* and *S. imperator* in southeastern Peru**

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Given the difficulty of raising twin offspring, and the necessity for assistance from the group, ideal breeding-opportunities are rare among callitrichids. Additionally, reproductive success is dependent on the physiological capability of an individual to attract a mate, copulate, and raise offspring. We studied *Saguinus fuscicollis* and *S. imperator* from southeastern Peru via a capture and release program. Using morphometrics and age data, we created a mechanism for determining primary, secondary or non-breeding status, which was correlated with reproductive success to detect reproductive suppression. We found no significant differences between species in the size of their genitalia or scent glands, despite differing markedly in their physical appearance. Primary breeding males had higher testicular volumes than secondary breeding males (44-287% higher in *S. fuscicollis* and 24-80% higher in *S. imperator*), indicating possible subtle reproductive suppression of males. Secondary breeding females had lower vulvar indices and suprapubic scent gland areas than primary breeding females, and required 2-3 y to acquire secondary breeding status compared to 1 y for males. While vulvar indices initially grow faster than testicular volumes in both species, by 1.5 years of age, males have fully developed genitalia while females still appear underdeveloped. Morphological scores assigned

to genitalia and glands could be used to distinguish infants from adults, but not other age classes. Overall, we found evidence of reproductive suppression, and highlight the importance of evaluating age based on dentition and not reproductive measures for either species, as reproductive suppression can cause animals to appear younger than they actually are.

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**Prey Switching by Chimpanzees at Ngogo, Kibale National Park**

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Chimpanzees (*Pan troglodytes*) prey on multiple vertebrates, but particularly target sympatric red colobus monkeys (*Piliocolobus spp.*). Heavy predation at Ngogo has caused a local red colobus population decline. Chimpanzees are mostly secondary consumers and prey availability should not affect their density, but meat's nutritional value makes continued hunting worthwhile.

We investigated whether the chimpanzees increasingly hunted major alternative prey -- redtail monkeys (*Cercopithecus ascanius*), grey-cheeked mangabeys (*Lophocebus albigena*), and guerezas (*Colobus guereza*) -- as red colobus availability declined. We confirmed earlier reports that encounters with red colobus, but not redtails or mangabeys, have declined, as have red colobus hunting and harvest rates. Guereza encounters (uncommon) have also declined. The likelihood of hunting alternative prey on encounter has increased over time and as encounters with red colobus have decreased (logistic regression). Elapsed time and variation in red colobus offtake together explain 15% of the variance in the rate of hunting alternative prey (multiple regression with robust SEs;  $p = 0.018$ ). Consequently, alternative prey have contributed increasing proportions of total offtake. However, hunts of redtails and mangabeys are still rare despite high densities of both, and success rates and the mean number of kills per successful hunt are lower than for red colobus hunts. While the overall rate at which the chimpanzees hunt these four species combined has not declined significantly, the harvest rate has decreased. The rate at which the chimpanzees hunt red colobus on encounter has not decreased; thus predation pressure on red colobus is still high.

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**A revised taxonomy of *Proconsul* modelled on dental variation in extant hominoids**

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For more than 60 years, debate has continued regarding the potential numbers of species of the early Miocene primate, *Proconsul* in eastern Africa. Leaving aside phylogenetic considerations, there is disagreement as to whether the alpha taxonomy allows for the presence of more than one species at each of the fossiliferous sites at Rusinga/Mfwangano Islands and adjacent Koru region in the Kenyan mainland.

The purpose of our investigation is to apply the concept of uniformitarianism to extinct species and assess size and shape parameters of the molars of *Proconsul* by testing those against similar parameters in four closely related extant hominoids: *Pan*, *Gorilla*, *Pongo* and *Hylobates*. Utilising calibrated views of the molar occlusal surfaces, we took sex-matched samples of 50 individuals from each of the modern taxa and compared these with samples of *Proconsul* from each of the island/mainland sites. The Coefficients of Variation for the paleontological material lie well outside those applicable to all combinations of neontological species, effectively falsifying the null hypothesis of a single *Proconsul* species at each site. To test for the presence of the putative *P. heseloni* and *P. nyanzae* at Rusinga/Mfwangano and *P. africanus* and *P. major* in the Koru/Songhor regions we used t-tests supplemented by bivariate plots to provide qualitative support. Linear dimensions, cusp base areas and cusp areal proportions differentiate *P. heseloni* from *P. nyanzae* and *P. africanus* from *P. major*. Based on our analyses we propose revised hypodigms for each species, including hitherto unrecognized mandibular molars of *P. africanus*.

**Dietary Ethanol Ingestion by Free-ranging Spider Monkeys (*Ateles geoffroyi*): An Examination of the 'Drunken Monkey' Hypothesis**

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The Drunken Monkey Hypothesis (DMH) posits that the proclivity of modern humans to consume alcohol may stem from a deep-rooted affinity present in all frugivorous nonhuman primates for naturally occurring ethanol within ripe fruit. Ethanol is a natural by-product of the metabolic activity of fermentative yeasts within fruit pulp that consume sugars made available as the fruit ripens. To date, the DMH has received little attention in the anthropological literature, limited

to demonstrations of ethanol concentration in fruit rather than primate diet choice. Here we investigate key assumptions and predictions of the DMH by examining the role that ethanol concentration in *Spondias mombin* (Anacardiaceae) fruits plays in the diet of free ranging spider monkeys (*Ateles geoffroyi*) on Barro Colorado Island, Panama (BCI). Partially consumed fruits were collected from the forest floor after being dropped by the monkeys. These fruits were then tested for ethanol concentration and sugar content in the laboratory. Specifically, we show that more than 85% of the fruits collected that were partially consumed by the monkeys contained measurable levels of ethanol. Additionally there is some evidence that the monkeys prefer fruits with ethanol concentrations in the 1-2% range. There was no significant relationship between ethanol concentration and sugar content of the fruits consumed. This research adds to the growing body of knowledge on primate food choice criteria, and may provide information pertaining to modern humans' relationship with alcohol.

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#### **Exomic copy number variation in the macaques**

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A large portion of the genome contains regions that exhibit both intra- and interspecific variation in copy number. These copy number variants (CNVs) can significantly impact phenotypic variation through dosage effects on gene expression and neofunctionalization of duplicated genes, suggesting that CNVs may have played a major role in primate evolution. To better understand the extent and potential role of copy number variation in the evolution of the genus *Macaca*, we sequenced the exomes of six individuals representing five species of macaques – *M. fascicularis*, *M. fuscata*, *M. mulatta*, *M. nigra*, and *M. thibetana* – including two populations of *M. mulatta*. We targeted the coding region of the genome using NimbleGen SeqCap v2.0 human capture probes (44.1 mb coverage) and sequenced the exomes on a single lane of an Illumina HiSeq 2000. We mapped reads to the rhesus macaque (*Macaca mulatta*) draft genome assembly (rhmac2) and then called CNVs using CoNIFER, which calls variants based on the normalized relative copy number of each exon in each sample based on read depth and coverage. We identified 216 variants among the six individuals and found that CNVs were nonrandomly distributed throughout the genome. In particular, 37% of CNVs overlapped with segmental duplications in the

rhesus genome assembly, and another 17% were in regions flanking segmental duplications. CNVs fell into a small number of functional categories, including a highly significant enrichment for olfactory receptor genes. Our results have implications for understanding structural variation in primates and molecular evolution in the macaques.

#### **Loud call variation in *Cercopithecus mona*: A proxy for genetic relatedness?**

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*Cercopithecus mona* is one of eight guenon species known to emit loud call vocalizations referred to as 'boom' calls. In mona monkeys, these vocalizations are short, tonal, double-phased calls that occur at low frequencies (Hz). Booms, generally emitted only by lead males in mixed-sex groups, are typically produced as responses to perceived threats, for territorial defense, or to initiate group movement. Variation in vocal ability and behavior is traditionally argued to be primarily genetic (i.e., 90%), with minimal (10%) plasticity attributable to learning. If vocal behavior is largely inherited, then inter-groups comparisons of boom calls can be used to estimate genetic relatedness. A population of mona monkeys on the island of Grenada were introduced over 350 years ago by slave ships; however, the source population in Africa has yet to be determined. We tested whether acoustic similarities in boom calls could help ascertain from which mainland African population the Grenadian *Cercopithecus mona* stemmed. We analyzed boom call duration and bandwidth in 18 boom calls from two *Cercopithecus mona* populations in Nigeria and compared them with previously analyzed calls recorded in Cameroon (n=19), Benin (n=17), and on Grenada (n=16). Calls from Nigerian *Cercopithecus mona* had an average bandwidth of 358 Hz (range ~ 118-774 Hz), and a duration of 122 ms, making them most similar to booms recorded from Cameroon. Calls from Benin and Grenada are distinctly similar, supporting the hypothesis that mona monkeys on Grenada are descendants of a population from Benin.

#### **Correlates of success in science classes**

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Student success, from the perspective of the college or university, is often measured by overall retention and completion rates, as well as cumulative grade point average. Contributing to these broad measures are the completion rates and letter grades of students in individual courses. By looking at correlates of student success in individual courses, we instructors may be able to improve student success whilst identifying broad strategies for success, and thus improve overall retention and completion rates. Here I present results from a systematic study of aspects of student behavior and identify how these relate to student success, as measured by individual exam and course grades. Two types of courses were investigated: two nursing program prerequisites, Human Anatomy and Physiology I with Lab, and Nutrition, and one general education science course, Human Evolution, all taught at Kirkwood Community College in Cedar Rapids, Iowa. Correlates of success included both overall attendance and attendance during the first two weeks of the semester, class meeting-time format (i.e., Tuesday/Thursday versus Monday/Wednesday/Friday), and the time it takes students to complete lecture exams. Results such as these allow us to compare student-based (e.g., attendance) and infrastructural (e.g., course scheduling) correlates of success across institutions and programs, and have the potential to improve student habits, inform course scheduling, and reduce student test-taking anxiety. These results are especially interesting in light of the current higher education climate emphasizing student assessment, institutional measures of effectiveness, and data-driven reform to improve student educational opportunities.

#### **Paternity analysis and friendship in a group of Kinda baboons (*Papio kindae*)**

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This study reports on paternity results and male-female relationships in Kinda baboons. Data was collected over a period of 36 months in Kasanka National Park, Zambia. From previous results it has been shown that Kinda males spent more time grooming and in social proximity to females than do other baboon taxa.

We analyzed 1944 10 minute focal samples to determine male-female and male-offspring relationships. We found that among all adult grooming, female-female grooming made up 40.5%, intersexual grooming accounted for 56.3%, and male-male grooming made up the remaining 3.2%. Examining the 56.3% of intersexual grooming, males groomed females 35.9% and females groomed males 20.4%.

The top 4-5 ranking males groomed and stayed in social proximity to the same females over the

entire study period. Interestingly, although there is a male linear dominance hierarchy, males of higher rank were not seen to monopolize reproductively receptive females that already had an established friendship with another male, regardless of rank.

Probable paternity was assumed from behavioral observations of male-female grooming and proximity. To confirm paternity we collected fecal samples for genetic analysis. We used 11 microsatellite loci to estimate paternity in father-infant/juvenile pairs. Contrary to expectation, not all males that groomed frequently with specific females fathered offspring with them during the study period. Further analysis will allow us to understand the general pattern of paternity and friendship in this group of baboons as well as gain a better understanding of the evolution of intersexual relationships in primates.

#### **Changing Skeletal Stress Following Social and Political Disruption at Karystos, Greece**

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This study tests the hypothesis that disease prevalence increased at the Greek mother city of Karystos after colonies were established and cultural contact increased through time. To test this hypothesis, bony changes that result from disease, including cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia (LEH), and periostitis were scored and recorded in 106 skeletons from Karystos, Greece. These bony changes are considered "non-specific" indicators of disease because they are caused by general physiological disruption, and not diagnostic of any specific diseases. The data revealed a nonspecific increase in skeletal stress through time. Specifically, prevalence of cribra orbitalia (19% to 41%;  $n=38$ ;  $X^2$   $p=0.15$ ), porotic hyperostosis (16% to 33%;  $n=37$ ;  $X^2$   $p=0.21$ ), LEH (67% to 82%;  $n=32$ ;  $X^2$   $p=0.31$ ), and periostitis (33% to 41%;  $n=49$ ;  $X^2$   $p=0.58$ ) increased from Classical/Hellenistic periods to the Roman period (with no change between the Classical and Hellenistic periods). Despite non-significant changes in skeletal stress through time, the consistent pattern of increased skeletal stress into the Early Roman period suggests there may have been a biologically significant difference in disease burden between these time periods. During the Early Roman period Euboean cities were revolting against the Athenian empire and Romans forced local people to pay tribute. This social and political changed may have caused the cities on Euboea (including Karystos) to lose some of their resources. With diminished resources, the people on the island of Euboea may have become more susceptible to disease. The impacts of small sample sizes and migration will also be discussed.

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#### **Investigating sexual differences throughout postnatal ontogeny in the craniofacial complex of human juveniles**

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Researchers have analyzed the developmental processes contributing to craniofacial variation from genetic, evolutionary, biomechanical and forensic perspectives. These studies have focused on understanding ontogeny in the facial skeleton to the exclusion of its relationship to adult morphological variation. Thus, while researchers have hypothesized that the long postnatal period of continued growth contributes to the high amount of variation observed in adult facial variation, this has yet to be shown empirically. To this end, this research uses three-dimensional geometric morphometric cranial data obtained from 304 CT scans of juvenile heads (aged between 2 years and 18 years) to assess the growth trajectories of five developmentally independent regions of the face: the left and right maxillary processes, the frontonasal process, the ethmoid, and the sphenoid. Two hypotheses are tested: (1) Males ( $n=147$ ) and females ( $n=157$ ) do not portray different developmental trajectories for the five developmental modules; and (2) facial proportions are set prenatally and are further elaborated throughout postnatal life through parallel developmental processes. Procrustes superimposition was used to scale and rotate the coordinate data, and principal component analysis and discriminant function analysis were used to assess shape differences in the five modules between males and females throughout ontogeny. Results indicate that males and females portray significant differences in the frontonasal module ( $p<0.01$ ) and the ethmoid module ( $p<0.01$ ), regardless of age. This research also indicates that developmental regions of the face maintain independent variances throughout postnatal ontogeny.

#### **Tuberculosis and leprosy cross-immunity hypothesis: *in vitro* test using human immune cells**

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Leprosy (LP) and tuberculosis (TB) are close related infectious diseases not only because the causal pathogens belong to the same genus: *Mycobacterium leprae* and *Mycobacterium tuberculosis* but because both pathologies can be associated with some related factors including compromised immune systems. Leprosy declined as an infectious disease in Western Europe after

the 13th century and one hypothesis suggests cross immunity exists between both pathogens, i.e. leprosy could have declined due to the rise of tuberculosis. Recent observations show co-infection between these diseases is rare in contemporary populations; with few cases documenting exposure to one *Mycobacterium* species provides humans some degree of immunity to other species. We developed experimental *in vitro* protocols to improve our understanding of how exposure to one *Mycobacterium* species (whole lysate) can generate a shift in the immune response that could affect the immune response to another species. During our two-day experiment, we exposed human peripheral blood mononuclear cells to either *M. tuberculosis* or *M. leprae* on day one; sequentially on day two, we exposed the same culture to the other species. The expression of key proteins (TNF- $\alpha$  and IFN $\gamma$ ) involved in the immune response against both pathogens was measured by ELISA. Interestingly, in some conditions (especially LP/first day-TB/second day) a differential expression of TNF- $\alpha$  was detected. This suggests that *in vitro* exposure to one *Mycobacterium* species can shift the immune response and modulate the response to the other species. We propose to generate alternative experimental protocols targeting other immunological markers for potential cross-immunity.

#### **Effects of terrain on reconstructions of mobility patterns**

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Femoral and tibial diaphyseal geometry has been used extensively to evaluate physical activity patterns in past populations, in particular mobility. The high antero-posterior (A-P) to medio-lateral (M-L) bending strength ratio (e.g.  $I_x/I_y$ ) typical of many hunter-gatherer femora, for instance, may reflect mechanical loads associated with long distance travel. The possible confounding effects of physical terrain on lower limb bone shape is rarely evaluated. This study investigates the possible effect of terrain on lower limb bone diaphyseal shape in adult skeletons from Europe, North America, Africa, and Asia, covering a time span from around 40,000 BP to the present. Midshaft femoral and tibial cross-sectional geometric properties for nearly 3000 individuals were gathered from databases kindly provided by researchers. Geographic coordinates were found for each archaeological site. Local terrain for each site was quantified with ArcGIS mapping software using USGS elevation data, and characterized as flat, hilly, or mountainous. Analysis of variance shows significant differences ( $p<0.032$  to  $p<0.0005$ ) in shape ratio ( $I_x/I_y$ ) of both femoral and tibial midshaft among the three terrain categories, with higher A-P bending strength in hilly and mountainous groups (Tukey HSD test).



This suggests that local topography needs to be considered when interpreting the cross-sectional properties of lower limb bones. Walking or climbing sloped surfaces is associated with greater A-P bending loads about the knee joint, so relatively greater A-P bending strength in the femur and tibia should be expected with more rugged local terrain.

#### Genetic identity and mitochondrial analysis of the Taita in eastern Kenya

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The Taita are Bantu-speaking agropastoralists who reside on a cluster of small mountains known as the Taita hills in eastern Kenya. Taita oral histories collected by researchers are conflicting, and an ancestral homeland is identified either to the north in southern Somalia, or to the south in Tanzania. Multiple factors influence both the genetic and ethnic identity of the Taita, and the archaeological and linguistic evidence does not definitively support either oral history. As the Taita moved into the region, they may have intermarried with other East African groups, particularly forager populations already inhabiting the Taita hills. Furthermore, historians doubt that the Dawida, Kasigau and Sagalla, named for the hills where they live, identified as a single Taita ethnic group prior to British rule. The British combined the hills into a single administrative unit and appointed chiefs instead of recognizing the authority of tribal councils.

DNA was extracted from cheek swabs of 156 individuals and the mtDNA HVRI was sequenced to identify specific haplotype frequencies among the three Taita groups. Our results indicate that the Taita are more diverse than nearby groups in the region, MDS plots show that the Taita cluster together tightly, and ANOVA analysis shows the among population variance  $F_{ST}=0.00$ . They also share more mitochondrial haplotypes with non-Bantu speaking groups in East Africa and share fewer haplotypes with Bantu speaking groups throughout Africa. They are closely related to other East African groups, and they likely incorporated foragers already living in the Taita hills into their population.

#### Alternative routes to reproductive success may explain male cooperation in a primate population (*Cebus capucinus*) with high reproductive skew

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Reproduction is skewed towards the alpha male in many primate populations, yet subordinate males often support the alpha during agonistic encounters with extra-group members. To improve our understanding of why subordinate males cooperate in populations with high reproductive skew, we investigated the siring success of dominant and subordinate male white-faced capuchins (*Cebus capucinus*) using 19 years of demographic and genetic data collected from 4 groups at Sector Santa Rosa, Costa Rica. Alpha males sired 91% of the infants born to unrelated females, and there was a trend for their reproductive success to increase with the number of subordinate males. Subordinate males were not more likely to remain in the group if they gained reproductive opportunities. Instead, the subordinate male's age relative to the alpha male had a positive effect on emigration, whereby males were more likely to emigrate as their age approached or exceeded that of the alpha male. If relatively young males are more likely to outlive the alpha, queuing for the alpha position is a more viable strategy for young than for old males. Some subordinate males gained reproductive opportunities when daughters of alpha males reached sexual maturity or when the former alpha male died or dispersed. These males sired a similar number of offspring as males that became alpha upon entry into a group. Alternative routes to reproductive success, which only become apparent when analyzing data over long time periods, may explain cooperation in populations with high reproductive skew.

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#### Comparative Placental Ecology at the Maternal-Fetal Interface

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The placenta acts as the conduit for fetal growth by transferring maternal nutrients, oxygen, and other molecules to developing offspring. In humans, the placenta implants interstitially and later burrows deeply into the uterine myometrium. At this stage, placentally derived

cells come into direct contact with maternal blood and immune cells. Contact between maternal and placental cells presents an immunological paradox because placental cells express proteins that are of paternal origin, thereby necessitating induction of tolerance so that the mother's immune system does not reject the placenta as it would other allografts. Interestingly, the maternal-fetal interface in the human placenta is not the only type found in primates, although it is the ancestral type. For example, strepsirrhines have evolved a less intimate type of maternal-fetal interface in which trophoblast cells do not destroy maternal epithelial cells. The placenta also varies in terms of its shape, type of interdigitation, direction of blood flow, and microbiome constituents. Catarrhines and strepsirrhines have branching, villous placenta interdigitation, while tarsier and platyrrhine maternal-fetal interfaces interdigitate via rod-like trabeculae. This anatomical and physiological diversity results in differing rates of embryonic development and fetal growth amongst the major primate groups. Examination of this natural variation provides insights into the etiology of human obstetrical syndromes and the developmental origins of adult health and disease (DOHAD). In particular, marmoset placenta biology provides insight into adult weight, perinatal outcomes, and reproductive outcomes. Finally, we discuss how epigenetic modifications due to environmental stressors such as poor nutrition and hypoxia affect fetal growth.

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#### Sociality of feeding and foraging in mantled howler monkeys, *Alouatta palliata*

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Distribution of food resources is a fundamental determinant of social systems in many primates. Evenly distributed resources are not easily monopolized and therefore usually left undefended. Numerous studies have shown that mantled howler monkeys, *Alouatta palliata*, are a folivorous primate and are generally non-territorial. This study investigated whether feeding and foraging is conducted with more frequency in isolation or in a social setting to determine if food quality and distribution influences social groupings in mantled howler monkeys. Because howler monkeys' preferred food sources are evenly distributed, the hypothesis predicted that there would not be a significant difference between the two conditions, isolated and social. This observational study was conducted on a howler monkey population on Ometepe Island, Nicaragua in June 2014. All data was collected using point sampling and analyzed with a chi-square significance test. The initial hypothesis was supported and there was no statistically significant difference between the amounts of

time spent feeding and foraging while in an isolated or in a social setting. Mantled howler monkeys spend equal amounts of time feeding and foraging while both isolated and social as there are few environmental factors that limit aggregate feeding size. Isolated individuals were also found to forage with more frequency than social individuals, likely due to increased ability for selectivity of higher-quality foods. This study contributes to the overall understanding of the relationship between social organization, foraging strategies and environmental factors in mantled howler monkeys.

#### The history and current census of *Chlorocebus sabaues* in Dania Beach, Florida

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Florida is home to over 500 exotic species with most being introduced by humans, including three primate species. The Florida Fish and Wildlife Conservation Commission reports breeding populations of rhesus macaques (*Macaca mulatta*) in Silver Springs State Park, Ocala, squirrel monkeys (*Saimiri* sp.) in three different counties, and green monkeys (*Chlorocebus sabaues*) in Dania Beach. This study focuses on the later population, as it is not well known among primatologists, yet multiple media reports exist about monkey sightings in urban areas. The main goals of this study were to (1) investigate historical records to understand the origins of the feral vervet population, and (2) conduct a census from January-August 2014 to examine the current population size. We found that the vervets escaped or were released from the Anthropoid Ape Research Foundation in the 1950's. This facility, established in the early 1940's, also known as the Chimpanzee Farm, imported primates to be sold for medical research. In 1957 the farm closed when Florida Power and Light bought the land. Through local reports and direct counts of monkeys we documented four groups (35 monkeys total) occupying the urban landscape and protected mangroves of Dania Beach. These groups live adjacent to businesses that offer provisioning year round. Our future research goals are to investigate the ecology and behavior of the vervet monkeys to understand how they have adapted to the South Florida mangrove habitat, and examine the dynamics of the human/non-human primate interface.

#### Reconsidering the diets of *Australopithecus africanus* and *Paranthropus robustus*

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*Australopithecus africanus* from Sterkfontein Member 4 and *Paranthropus robustus* from

Swartkrans Member 1 are associated with carbon isotope values indicative of a mixed C<sub>3</sub>/C<sub>4</sub> diet. Dental microwear texture analysis conducted previously on these fossil taxa suggested hard-object consumption characterized both, particularly *P. robustus*. In this study, previously unconsidered *A. africanus* (n = 8) and *P. robustus* (n = 13) specimens are examined using dental microwear texture analyses to validate prior dietary reconstructions from dental microwear and carbon isotopes. There is more variation in complexity and textural fill volume in *P. robustus* compared to *A. africanus*. While *A. africanus* exhibits higher values for anisotropy than does *P. robustus*, the two fossil taxa contrast with folivorous monkeys, such as *Trachypithecus cristatus* and folivore-frugivores such as *Alouatta palliata* suggesting large amounts of leaves were not consumed. *Australopithecus africanus* and *P. robustus* exhibit moderately elevated complexity values, differing significantly from those of *T. cristatus* and *A. palliata*. The textural fill volume of *A. africanus* and *P. robustus* differs significantly from that of tropical forest primates which may indicate these individuals ingested hard particles during mastication, or differences in habitat ecology are reflected in textural fill volume. A multivariate cluster analysis groups the fossil taxa together to the exclusion of tropical forest primates. Consumption of underground storage organs with concomitant ingestion of extraneous grit may help explain the elevated textural fill volume in these two taxa, and would account for the presence of a C<sub>4</sub> isotopic signal in *A. africanus* and *P. robustus*.

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#### Tending the Vines: Biomechanical Evidence of Laterality and Gendered Labor Division in Viticulture at Pessinus, Turkey

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Skeletal remains from Sankuş Mevkiinde Tomb (Late Roman, AD 200–300) at Pessinus, Turkey included 12 adult males with asymmetrical, robust definition of the peroneal trochlea extending outward (>1 cm) from the lateral calcaneus and situated between the peroneus longus and brevis tendons, nine of which are on the right calcaneus. Adult females did not exhibit this variation. Asymmetrical variation suggests repeated biomechanical eversion of the foot and plantar flexion of the ankle on the side affected when recovering from crouching and kneeling on one knee. Biomechanical stress laterality is also reflected in knee, wrist, and elbow joints of the same individuals, but not in shoulder joints. Right-preference laterality (90-92%) in humans

indicates primary use of the right hand-right leg for a specific kneeling task. Roman tombstones for local males depict vine-hooks and handpicks (cf. weaving apparatus for females). Intensive use of these tools in tending vines is consistent with stresses in wrists and elbows and gender imbalance within the sample. Enduring local practices of tending untrained vines at ground-level account for indications of repetitive kneeling in the same individuals. This holistic view of biomechanical stress and ancient iconography reconstructs techniques and gendered division of labor in ancient viticultural practice.

#### The Gut Microbiome of Howler Monkeys (*Alouatta palliata*) in Costa Rica

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The human gut microbiome has been well characterized in modern and, increasingly, with new technologies, ancient populations. The gut microbiome of non-human primates is underway for the great apes, Old World monkeys, such as guenons, colobus, and vervet monkeys, and New World monkeys.

In this study, we characterized the gut microbiome of nineteen howler monkeys (*Alouatta palliata*) from Costa Rica and evaluated differences in microbial communities across the following age groups, babies (age 10–12 months old), juveniles (1–3 years old), and adults (over 3 years old), using QIIME and LEFSe.

The howler monkey microbiota is dominated by Firmicutes (genera *Oscillospira*, *Faecalibacterium*, and *Coprococcus*), which represented on average 44% of each sample. Other phyla present include Bacteroidetes (genus *Prevotella*), in addition to 13% unclassified bacteria from the Bacteroidetes (genus *Bacteroides*), the Firmicutes (genera *Clostridium*, *Anaerostipes*, and *Vallitalea*), and the Proteobacteria (genera *Laminaire*, *Diazotrophicus*, and *Fabarum*).

Beta diversity analysis reveals cluster segregation of baby and juvenile microbiota from adults. A total of eighteen statistically significant biomarkers differ across age groups. Babies/juvenile howler monkeys had higher abundance of *Haemophilus* and adults had increased representation of *Faecalibacterium*, *Oscillospira*, *Ruminococcus*, and *Rubrivivax*.

These results are consistent with the dominant phyla of the great apes, including humans, and Old World monkeys, which are also Firmicutes, Bacteroidetes, and Proteobacteria dominated. Continued work on the gut microbiome of non-human primates will provide insights to our shared evolutionary histories and enhance understanding about the development of the human intestinal ecosystem.

#### Complex evidence of stress in medieval and post-medieval central Europe

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The study of multiple osteological indicators of stress provides nuanced insights into developmental stress. Chronic stress throughout development is reflected in long bone lengths, while acute periods of stress during early childhood can leave linear enamel hypoplasias (LEHs). These complementary lines of evidence are examined to test the hypothesis that climate change during the Little Ice Age (AD 1300-1850) is linked to increased physiological stress in medieval and post-medieval central Europe. To test this hypothesis, femoral and tibial maximum lengths were measured, and LEHs on anterior teeth were recorded in five medieval and post-medieval German and Austrian skeletal series (n=246) using the Global History of Health Project standards. The analysis revealed that average male and female femur lengths and average male tibia lengths increased in the Little Ice Age (LIA), although these differences were not statistically significant (ANOVA,  $p > .05$ ). In contrast, overall LEH prevalence and frequency of multiple LEHs per tooth were higher in the LIA than in the preceding period. More specifically, the proportion of individuals with two or more linear disruptions in at least one anterior tooth was significantly different ( $X^2$ ,  $p < 0.000$ ) between the LIA (73.1%), and the preceding period (34.3%). These results indicate that childhood stress was frequent enough to leave multiple disruptions in the dentition, but not of such duration or severity that it resulted in shorter adult stature. These results contribute to a growing understanding of the variable regional impacts of the Little Ice Age.

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#### Relationships between muscle architectural anatomy and the morphology of entheses in the thenar and hypothenar regions of modern humans

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Paleontologists and bioarcheologists frequently use muscle markings (entheses) on bones to infer behavior during life. One region which relies strongly on entheses for functional interpretation is the hand. In particular, anthropologists have relied on entheses of the thenar and hypothenar regions of hominin remains to evaluate whether the individuals engaged in stone tool behaviors. Little is known, however, about the relationship between the mechanics of these muscles and their entheses; the effects of frequent or strenuous muscle recruitment on the morphology of these insertion sites are also poorly understood.

Here we test the hypothesis that aspects of muscle architecture and mechanics including overall muscle belly length, fiber lengths, and physiological cross-section area positively correlate with a size and shape change of the enthesis. Gross and microscopic measurements were taken on thenar and hypothenar muscles as well as the flexor pollicis longus (7 muscles total) and the associated entheses from twenty human cadavers of both sexes, ages 60 to 100 years old. Contrary to our hypothesis, preliminary results show no consistent patterns between muscle architecture and enthesal change. However, a similar study using mice as the test organism discovered that the underlying cortical bone thickness of an attachment site is more informative of the associated muscle anatomy. Results of these studies together caution the use of enthesal surfaces to interpret past hominin behaviors, such as stone tool making. Instead, internal bone structures and cross-sectional properties of the entheses may be more reliable for making inferences from skeletal and fossil remains.

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#### The most unkindest cut: genital wounding by chimpanzees

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Victims of chimpanzee violence often suffer genital wounds. This suggests that chimpanzees target genitalia as an adaptive strategy to damage a rival's reproductive capacity. In this case, genitalia should be targeted more frequently during escalated attacks (such as killings and the overthrowing of alpha males). An alternative hypothesis is that genitalia are damaged frequently simply because they are large and unprotected, in which case similar frequencies of genital wounding would be expected from routine and escalated aggression. To test these hypotheses, we examined data on wounding from Gombe, Tanzania (2004-2012), Fongoli, Senegal (2006-2014) and Ngogo, Uganda (1995-2014), as well as killings reported from all long-term studies. Among males, genital wounding occurred only in escalated fights, including two overthrows of alpha males (Fongoli), and the killing of a former alpha male (Gombe: 1/65 wounding events = 1.5%). In contrast, fatal attacks on males commonly resulted in genital wounds (9/22 cases = 40.9%). Unlike males, females frequently suffered genital wounds (Gombe: 17/58 wounding events = 29%). Males – the main attackers of both males and females – thus rarely wounded the genitalia of other males, except during escalated aggression, but frequently wounded female genitalia. These findings are consistent with the hypothesis that attackers specifically target genitalia, but do not rule out additional hypotheses. For example, sex differences in wounding may result from differences in fighting patterns, if females more commonly flee than face their attackers. Additionally, during killings, victims are commonly pinned down on their backs, thus exposing their entire ventrum to damaging aggression.

#### Folivores, frugivores, and *Theropithecus*: Diet and dental topography in cercopithecoids

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Cercopithecoids masticate many food types including hard and/or tough seeds, tough mature leaves, and in the case of *Theropithecus* fibrous grass blades. We hypothesize that cercopithecoid molar topography is adapted for dietary demands in a manner similar to that documented for other mammalian clades. We predict that colobine dental morphology will reflect folivorous diets, and that *Theropithecus* will reflect its unusual ungulate-like grazing. Casts of 75 mandibular molar rows with relatively unworn second molars (m2s) belonging to 19 of 21



cercopithecoid genera were microCT-scanned yielding digital surfaces of m2s. Metrics of occlusal surface relief (RFI), curvature (DNE), and complexity (OPCR) were calculated using Morphotester, software designed for this purpose. Results support both predictions. Occlusal curvature and relief are higher (DNE:  $p = 0.028$ ; RFI:  $p = 0.001$ ) in colobines than cercopithecines, reflecting diets higher in quantities of tough leaves and seeds. Cercopithecines unexpectedly exhibit more complexity (OPCR:  $p = 0.040$ ). Though other primates consuming fibrous foods (e.g., bamboo) have high complexity, the same is also expected for grazers. The latter, but not the former should also have high RFI due to hypsodonty. *Theropithecus* evinces grazing behavior, yet its dental topography better matches primate fibrous food-eaters in a broader sense with exceptional complexity, but average RFI. Unlike those taxa, however, *Theropithecus* also has relatively high curvature. As a further indication of the functional significance of occlusal topography in *Theropithecus*, there is an inverse correlation between RFI and complexity/curvature, suggesting these teeth appear adapted to improve and maintain functionality with wear.

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#### **Complete Mitogenome Sequencing of Late Woodland domesticated dogs from Janey B. Goode**

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Dogs and humans likely have a shared migration history due to their close interactions, and studying dog population histories may yield answers to questions about how human populations migrated and interacted as well. Humans traveled with domestic dogs to the Americas, and dog remains in North America date back to at least 9000 years before present (ybp).

Dogs have been present in the American Bottom for thousands of years, although their importance and roles in prehistoric society changed over time. Skeletal remains of dogs show they were used as labor, food, companions and ritual offerings.

At the Janey B. Goode (JBG) site (11S1232), more than fifty dog remains have been recovered from the Terminal Late Woodland component (1000-1400 ybp). 44 of 50 dogs sampled have been successfully sequenced over a short region of mitochondrial DNA, showing relatedness to dog remains in Siberia, the American Southwest

and Peru. Twenty of these individuals were chosen for complete mitogenome sequencing, and their sequences were compared with other published sequences. Despite the large sample size, the JBG dogs have low levels of genetic diversity, suggesting that the dog population that first migrated to the American Bottom was small. The JBG mitogenomes also show similarity to mitogenomes from dog burials from 9000 ybp in Southern Illinois, suggesting population continuity from the Archaic through the Late Woodland periods in the American Bottom. Information about the dogs in the American Bottom has the potential to apply to humans as well, to track their migration history.

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#### **Artificial Deformation vs. Normal Variation: Re-examination of the Deformed Craniums in Ancient Korea Populations**

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According to the Chinese historical record, artificial cranial deformation was practiced by some ancient Korea populations. It is on record that when a baby was born, the parents would press the baby's head under a stone to make it more angular. Currently, the cases of artificially deformed craniums in Korea are only reported in the Yean-ri population, South Korea. The purpose of this research is to re-examine these artificially deformed craniums based on Procrustes superimposition and Principal component analysis. More specifically, this investigation was carried out in an effort to evaluate the aspect of the deformed shape through comparisons with normal specimens and to explore the method used to deform the head in the Three Kingdoms Period.

Cranial landmarks from a lateral perspective from 26 individuals, dated to the Three Kingdoms Period, were digitized to differentiate between the changes resulting from artificial deformation and the normal cranial variations. The coordinate data were subjected to a Generalized Procrustes analysis, after which a principal component analysis was conducted to examine the directions and magnitudes of the shape changes in the sample.

In the results, the frontal flattening (43.8%) and occipital flattening (19.6%) accounted for the majority of the variation in the sample. These results indicate that using the directions and magnitudes of shape changes in the frontal and occipital regions can help to identify the

presence or absence of artificially deformation in ancient Korea populations. In particular, it is judged that deformation resulted from frontal flattening by a primary deforming force.

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#### **Chimpanzee hand-clasp grooming, a socially learned tradition, as a marker of social relationship**

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Hand-clasp-grooming (HCG) is a distinct and visually obvious style of chimpanzee mutual grooming that is restricted to certain communities. We analyzed inter-individual variation in the practice of HCG so as to assess whether HCG signals a special quality of social relationship. Using > 200 focal observations of  $\geq 10$  hours duration from the Kanyawara community of Kibale chimpanzees from 2009-2013, we found that adult males averaged 2.1 minutes of HCG per day, compared to 0.7 min/day for adult females. In single-sex grooming dyads, males used HCG at twice the rate of females (HCG as % of grooming minutes: male-male 4.4%, male-female 4.1% female-female 2.2%). Despite these sex differences there was no overall relationship between the frequency of HCG and the strength of affiliative relationship (determined by high rates of temporal and spatial association). By contrast, unlike HCG frequency, HCG style varied in meaningful ways. Photographs of 542 HCG dyads showed that among adults, individuals had higher rates of palm-to-palm contact with maternal kin (mean 36.2%) than non-kin (16.9%,  $N = 11$ ,  $P < .02$ ). Kanyawara chimpanzees also exhibited a higher frequency of palm-to-palm contact (median male 19.8%, female 22.2%) than in Mahale M-group chimpanzees (median 5.3%), the only wild chimpanzee population with sufficient data available for comparison. We suggest that the style, but not the frequency, of HCG is a socially learned trait that reflects the proximity of social relationship.

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### Variation of Enamel Decussation in the Permanent Molars of *Papio ursinus*

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Enamel decussation is considered by many workers to convey information of taxonomic and functional value. While some quantitative parameters have been examined in this regard, these measurements have been recorded mostly in small samples of fortuitously fractured molar teeth. In an attempt to gain an idea of the intraspecific metameric variation in enamel decussation, we analyzed a number of quantitative parameters, including Hunter-Schreger band width, length, orientation and curvature, and the strength of decussation in permanent molars of the chacma baboon, *Papio ursinus*. Nearly equal numbers ( $n \approx 10$ ) of unworn to slightly worn upper and lower M1s, M2s and M3s were sectioned through the tips of the dentine horns. The specimens were examined by scanning electron microscopy, and micrographs were recorded for buccal and lingual sides of lateral enamel at magnifications of 200x and 1,000x to provide for measurement of various decussational parameters.

Metameric trends from M1 to M3 are not observed in either Hunter-Schreger band width or the strength of decussation. Hunter-Schreger band width exhibits no significant difference between the buccal and lingual sides of molar crowns with the exception of the maxillary M2. Similarly, decussational strength shows no significant difference between buccal and lingual sides with the exception of the upper M2. These observations are unexpected according to models that predict functional differences along the molar row or between the sides of the crown that support the "guiding" (Phase I) and "functional" (Phase II) cusps.

### A comprehensive phylogenetic study of cranial morphology in Southeast Asian mammals

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According to the island rule, there is a general evolutionary trend for large-bodied mammals to undergo reduction in body size on islands (especially small ones) because food resources are severely limited. Here, we present data for both volumetric measurements and 3D morphometric cranial landmark dimensions related to body size to document the evolution of

mammalian cranial morphology on islands. Taking a dataset for three large-bodied taxa from Southeast Asia, including 125 individuals from 11 gibbon species (family Hylobatidae), 64 individual longtailed macaques (*Macaca fascicularis*), and 32 individuals from six pig species (family Suidae), we found that a large percentage of total variance in all three taxa is explained by size. This indicates that larger individuals have relatively more robust mandibles and cranial area for muscle attachments. However, it is important to take intraspecific phylogenetics into account when analyzing such geometric morphometric data because there are apparent differences in within-species variation on different islands. We have successfully sequenced mitogenomes from 50-150 year old museum specimens using the Illumina platform to build intraspecific phylogenies for a comprehensive phylogenetic study of cranial morphometric data in the taxa investigated.

### Allometric shape change in the talar articular surfaces of euarchontans

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Some articular surfaces of the primate talus have been shown to scale with positive allometry, particularly the ectal and fibular facets. These scaling relationships may indicate increased demand for the stability at the joint, or the ability to transmit force without displacement or failure. Altering the shape of the facet could also facilitate stability, since more circular facets would be more resistant to displacement under multidirectional loading. Here, we examine the relationship between body size and facet shape of several articular surfaces of the primate talus. Four facets (lateral tibial, medial tibial, fibular, and ectal facets) were cropped from microCT scan-generated surfaces from a comprehensive sample of euarchontans. For each facet, area and perimeter were measured with Geomagic Studio software. A measure of facet shape was calculated by taking the ratio of facet perimeter to the square root of facet area. This ratio was log-transformed and regressed against literature-derived log-body mass using phylogenetic and ordinary least squares methods. Among primates, the shape of the ectal and fibular facets scales with significant negative allometry: smaller primates have more elliptical facets, while larger species have more circular facets. Among haplorhines, the fibular facet scales with significant negative allometry. The shape of the lateral tibial and medial tibial facets does not have a significant relationship with body mass in any of the examined groups. These results suggest that there is an increased demand for stability on the lateral margin of the talus (which bears the fibular and ectal facets) as body mass increases.

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### LINE1 DNA methylation is associated with telomere length in African American children

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DNA methylation is an epigenetic modification that occurs primarily at cytosines followed by guanines (CpG sites), and are often associated with regulation of gene expression. Telomeres are repetitive DNA sequences at the ends of chromosomes and are considered a marker of biological aging. Experiments *in vitro* and with mouse models suggest that DNA methylation in subtelomeric regions of chromosomes may play a regulatory role in telomere maintenance. In human leukocytes, telomere length has shown a positive correlation with global DNA methylation levels, as estimated with LINE1 methylation. No previous studies have examined the association between DNA methylation and telomere length in other tissues, children, or in specific racial populations. This study examined the association between relative telomere length and LINE1 methylation in DNA extracted from buccal swabs. DNA was collected from 120 primarily African American children between the ages of 5-15 in New Orleans, Louisiana. DNA methylation was measured at 3 CpG sites of LINE1 with bisulfite pyrosequencing, and relative telomere length was estimated using a multiplex real time PCR. Preliminary results ( $n=46$ ) show a significant positive correlation between telomere length and LINE1 methylation with the mean across CpG sites ( $r=0.31$   $p=0.035$ ). The association was strengthened when 5 non-African American children were removed from the sample ( $r=0.37$   $p=0.016$ ). In linear regression models, correlations remained significant after adjusting for age, sex, mother's age, and mother's education. In light of previous experiments, these findings support the theory that DNA methylation in the subtelomeric regions may play a role in regulating telomere length.

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### Greater family size is associated with less sleep among Tsimané parents

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Sleep has a demonstrated restorative effect on the body, supporting the interpretation of sleep as a maintenance behavior. A life history model of human sleep proposes that time allocated to sleep is optimized as a product of tradeoffs. Reproductive investment in humans largely manifests as childcare for dependent children, often coming at the direct cost of sleep in parents with very young children. To see how sleep and childcare tradeoff at night, sleep was measured among the Tsimané of lowland Bolivia (total fertility rate = 9). 71 adults (mean  $\pm$  SD: age =  $35.4 \pm 12.28$ , range = 13-59, 58% female) were sampled for an average of 5.5 nights per person using the Philips Respironics Actiwatch 2, an accelerometry-based wrist-worn sleep monitor. Average sleep duration was  $6.56 \pm 1.56$  hours (men  $6.29 \pm 1.53$ , women  $6.75 \pm 1.55$ ). Average waking events attributed to children per night was  $.27 \pm 0.61$  for men and  $1.06 \pm 1.45$  for women. Age of youngest child decreases nightly childcare awakenings for women. Baby presence was not significantly associated with total sleep, likely due to small sample ( $n=7$ ). Number of children under age 18 decreases sleep for parents, especially men. Number of children over age 18 is associated with decreased sleep, but only for women. These findings support sleep duration as the outcome of a time-allocation tradeoff. Women are foregoing sleep to perform childcare at night, while men are also losing sleep due to children, but for other purposes related to childcare, perhaps food production.

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#### **Discriminating tarsier acoustic forms from Sulawesi's northern peninsula**

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MacKinnon and MacKinnon (1980) hypothesized the presence of two tarsier acoustic forms from Sulawesi's northern peninsula, which they dubbed the Manado and Gorontalo forms, with a hypothesized boundary at the Isthmus of Gorontalo. Shekelle (2008) found support for these two forms with playback experiments on wild populations, but existing spectrographic analysis provided only weak support. Previous analyses of tarsier acoustic forms have been heavily weighted toward characters that might not reflect the prevailing tendencies in the tarsier calls. In this study, we further tested the hypothesis of two tarsier acoustic forms using the quantification of temporal and spectral characters of both male and female calls. We compared duet structure of tarsier duets from two regions. Female duets from Gorontalo have significantly more phrases per duet and significantly shorter phrases. Both inter notes

interval (INI) and inter phrases interval (IPI) were significantly different in the two forms of the female calls ( $P<0.001$ ). The Manado form exhibited longer INI and IPI. Peak frequency of female duets from Manado were statistically higher than female duets from Gorontalo ( $P<0.001$ ). Male calls from Gorontalo change as female calls change, while male calls from Manado are less influenced by female call. Our results strongly support the hypothesis of two acoustic forms. Our methodology provides inference into duet evolution, with the Manado form seen as an elaborated version of the Gorontalo form.

#### **On the Non-Existence of Cold, Wet Air and Implications for Studies of Human Nasal Variation**

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Investigations into the selective role of climate in the evolution of human nasal variation have typically divided climates into four broad categories: hot-dry, hot-wet, cold-dry, and cold-wet. However, these climatological categories are partially based on relative humidity (ratio of actual vapor pressure to maximum possible vapor pressure). Yet, it has long been recognized that absolute humidity (actual amount of water vapor present in a given volume of air) – not relative humidity – is physiologically more important during respiration. Unlike relative humidity, absolute humidity is directly constrained by temperature, such that reductions in temperature result in concomitant decreases in the maximum absolute humidity possible. Thus, cold air is inherently dry air, making “cold-wet” air a climatological impossibility. Accordingly, to better understand the demands different environments place on nasal physiology, we reanalyzed data from Thomson and Buxton (1923), who investigated the relationship between climate and the nasal dimensions of over 15,000 individuals from 147 geographic localities around the globe. Given that inspired air must be warmed to body core temperature (37°C) and saturated with water vapor (100% relative humidity; absolute humidity = 49.3 mg/L) prior to entering the lungs, we calculated the actual amount of heat and water that must be transferred to inspired air under different climatic conditions. Our results indicate that breathing in all cold climates requires a substantial amount of moisture be transferred to inspired air, with individuals traditionally assigned to “cold-wet” environments requiring similar levels of humidification as those from “cold-dry” environments.

#### **Musculoskeletal stress markers of males and subsistence strategy changes between Jomon people and Yayoi people**

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In this study, differences in habitual physical activities and workload are explored using musculoskeletal stress markers (MSMs) of the upper and lower limbs of males over samples of Prehistoric Jomon foragers (14,000-2,500BP) and Yayoi agriculturalists (2,500-1,700BP BP). Nineteen MSM sites on the right side of upper and lower limbs were scored according to Hawkey and Merbs (1995).

Jomon samples are statistically significantly different when compared to Yayoi samples for 10 of the 19 total MSM sites. In particular, MSM scores on 2 sites on the lower limb are scored significantly higher in Yayoi samples than Jomon samples. The observed differences, especially on lower limbs, can be attributed to the different habitual activities associated with labor-intensive wet rice agriculture by Yayoi people. Geographic criteria were used based on locations of settlements such as inland and coastal areas. Jomon samples separated into 4 groups and Yayoi samples into 3 groups. The differences within these geographic groups are examined for each total Jomon and Yayoi sample. The variability of the differences within the groups is then compared. This found that the within-group variances of among Yayoi groups are smaller than within-group variance among Jomon groups.

The interpretation of these results is that Jomon groups had practiced different subsistent activities, while all Yayoi groups had practiced agriculture in a similar way. This finding coincides with archaeological research that indicates that although each Yayoi group may have minor differences in food availability and geographic location of the sites, they are otherwise very similar.

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#### **Using Population Health Constructs to Explore Disability in Bioarchaeology**

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Population health research has demonstrated that social and physical environmental factors impact people afflicted with different health conditions. This should also apply to earlier populations where the human condition is not entirely dissimilar to that of today. Examining a disease state in archaeological populations without the benefit of contextual information limits our understanding to the biological. However, individuals are more than simple biological



entities, they are biopsychosocial composites born, shaped, and embedded in social and physical environments. To understand the impairment potential of disease, bioarchaeological researchers must embrace this holistic view and not limit examinations to a restrictive biological lens that places every geographical and cultural group of varying circumstance on equal footing.

The effect of knee osteoarthritis on individuals is symptom based. Pain, stiffness, and instability impact the capacity for function and mobility, leading to movement modifications to avoid symptom intensity. Using knee osteoarthritis, an osteological correlate was developed to link lifestyle variables to bone changes in the distal femur. This qualitative MRI based system was examined through frequency distributions, probability profiles, and Spearman's rank correlations. The results suggest that while the five outcome variables with the highest probabilities were common to males and females, bone changes in knee osteoarthritis impact males and females differently. Exploring these results using the multiple determinants of health model assists in understanding the non-linear relationship between biological changes and outcomes and provides a framework for improved interpretation of impairment and disability in archaeological populations.

#### The mechanics of arboreal stability in squirrel monkeys (*Saimiri boliviensis*)

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The need to maintain stability in a narrow-branch arboreal environment is often cited as a primary selective pressure shaping primate locomotor morphology and behavior. Specifically, grasping extremities, in combination with gaits emphasizing contralateral fore/hind foot support, are thought to improve lateral stability by facilitating the production of opposing torques about the branch. We tested this hypothesis by collecting kinematic and kinetic data from two squirrel monkeys (*Saimiri boliviensis*) crossing a range of simulated arboreal supports (1.25cm, 2.5cm, and 5cm in diameter; n=12 strides per substrate). Kinetic data were collected using a custom-built array of force poles that permitted the measurement of torques from individual limbs as well as changes in whole-body angular momentum about the support ( $\Delta L_{sup}$ ).  $\Delta L_{sup}$  served as our primary metric of lateral stability – if  $\Delta L_{sup}$  becomes too large, the monkey will be unable to arrest its angular movement and will fall from the support.

Monkeys exclusively used diagonal sequence gaits across all substrate diameters, emphasizing support by contralateral fore- and hind limb bipods. Within strides, left and right limbs

imparted torques that were equal in magnitude ( $p=0.62$ ) but opposite in direction. As such,  $\Delta L_{sup}$  decreased with the amount of time spent on contralateral bipods, which permit cancellation between left and right limbs (partial correlation controlling for speed:  $r=-0.419$ ,  $p=0.016$ ), but increased with the amount of time on ipsilateral bipods, which prevent cancellation between limbs (partial  $r=0.552$ ;  $p=0.001$ ). These findings constitute the first empirical evidence that gait selection directly affects locomotor stability during primate arboreal quadrupedalism.

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#### Dental Phenetic Variation in a Mass Human Sacrifice on the North Coast of Peru: Kinship, Mortuary Symbolism, and Identity among the Victims of Matrix 101 (Middle Sicán Culture, A.D. 1050/1100)

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Between 1050-1100, an unprecedented El Niño event struck the Peruvian coast, with waves of torrential rainfall and destructive flooding hitting the capital of the Middle Sicán (or Classic Lambayeque) theocratic state in the mid La-Leche Valley. One response which unfolded in the course of this event was the mass sacrifice of over 200 people in a mass grave designated Matrix 101 (M101), nearly at the center of the Grand Plaza of Sicán. Sixteen months of excavation from 2011-12 uncovered this extraordinary context. Many victims were arranged in clusters or ring-like groupings. Given the meaningful links between spatial organization and kinship in other Middle Sicán funerary contexts, we sought to examine if kinship was also intentionally represented in M101.

We undertook an exploratory multivariate analysis of inherited mesiodistal and buccolingual tooth sizes and non-metric tooth crown variation (using the ASU DAS). Data were collected from the 60 best preserved individuals. Following data winnowing, hierarchical cluster analysis of interindividual Euclidean distances demonstrated that closely related kin were generally not buried in immediate proximity to one another in M101. Representing kinship appears largely unimportant to this crisis ritual. However, a general lack of nonmetric trait variation and low variance within Euclidean distance matrix itself indicates the sample may be genetically quite homogenous. Variation of some molar cusp phenotypes resembles those previously observed among the endogamous elite social strata. These initial observations are concordant with other evidence suggesting the lords of Sicán may have

been sacrificing themselves in the face of ecological calamity.

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#### Transethnic meta-analysis of exomic variation contributing to central adiposity

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Central adiposity is a leading risk factor several chronic diseases, and evidence suggests genetic factors contribute to central fat distribution, measured as waist to hip ratio adjusted for BMI (WHR<sup>a</sup>). To date, 33 loci have been associated with WHR<sup>a</sup>, more than half of which are sexually dimorphic. While most genetic studies focus on common single nucleotide variants (SNVs) in

European-descent populations, we aim to identify large effect, low frequency variants (minor allele frequency [MAF <5%]) associated with WHR<sup>a</sup> using exome data from 90,224 women and 75,759 men of European (90%), African (8%), and Asian (2%) ancestry.

We performed fixed effects meta-analyses of study-specific WHR<sup>a</sup> association results stratified and then combined across all ancestries. Analyses included up to 236,047 SNVs on the exome array (201,126 with MAF<5%).

Four variants reached genome-wide significance (GWS) ( $P < 5 \times 10^{-8}$ ) in men, with one novel finding in *RREB1* (MAF 40%). Sixteen variants reached GWS for women, including two novel findings in *RAPGEF3* (MAF 1.8%) and *DNAJA3* (MAF 29%). The LRV within *RAPGEF3* showed a larger effect ( $\beta = 0.1385$ ) on WHR<sup>a</sup> than common variants in the same gene ( $\beta = 0.0263$  to 0.0618). *RAPGEF3* is involved in angiogenesis and insulin regulation, and its activity is decreased by progesterone, suggesting a biological mechanism for why this signal is seen only in women.

Our results highlight the importance of large-scale genomic studies for identifying LRVs influencing central fat distribution. Understanding these genetic effects will provide insights into the progression of central obesity and highlight sex-specific variants that increase susceptibility.

#### Body Mass Estimation from Pelvic and Femoral Variation among Modern British Women of Known Mass

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Femoral head diameter is commonly used to estimate body mass from the skeleton. The three most frequently employed methods, designed by Ruff, Grine, and McHenry respectively, were developed using different populations to address different research questions. They were not specifically designed for application to female remains, and their accuracy for this purpose has rarely been assessed or compared in living populations. This study analyzes the accuracy of these methods using a sample of modern British women through the use of pelvic CT scans ( $n=97$ ) and corresponding information about the individuals' known height and weight.

Results showed that all methods provided reasonably accurate body mass estimates (average percent prediction errors under 20%) for the normal weight and overweight subsamples, but were inaccurate for the obese

and underweight subsamples (average percent prediction errors over 20%). When women of all body mass categories were combined, the methods provided reasonable estimates (average percent prediction errors between 16-18%). The results demonstrate that different methods provide more accurate results within specific BMI ranges. The McHenry Method provided the most accurate estimation for women of small body size, while the Original Ruff method is most likely to be accurate if the individual was obese or severely obese. The Refined Ruff Method was the most accurate predictor of body mass on average for the entire sample, indicating that it should be utilized when there is no knowledge of the individual's body size or if the individual is assumed to be of a normal body size.

#### Changes in tooth form between Roman, Anglo-Saxon and modern periods in Britain: a study of differences in size, morphology and wear

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This study analysed differences in dental anatomy and wear, extracting geometric morphometrics from microfocus computer tomography ( $\mu$ CT) datasets. Samples of permanent incisors and canines were studied, from British groups:

- 1) Roman, Huntsman's Quarry, 2<sup>nd</sup>-3<sup>rd</sup> Century AD,  $n=14$ ,
- 2) Anglo-Saxon, Great Chesterford, 5<sup>th</sup>-7<sup>th</sup> Century AD,  $n=62$ ,
- 3) Modern, Essex, 2012-2014 AD,  $n=60$  (NRES ref.12.LO.0901).

Specimens were categorised by estimated age and sex, and scored qualitatively for wear (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 removal to allow cemento-enamel junction (CEJ) visualisation, and aligned in space. Twelve crown, root and CEJ measurements were taken, physically and by automated landmark identification, and enamel, root and whole tooth volumes and surface areas were calculated.

The computational and physical measurement methods correlated closely ( $R^2=0.86-1.00$ , Gradient=0.79-1.06) for crown and root

diameters and lengths. The results agreed with established trends, in decreased wear score from archaeological to modern samples, and a positive odontometric trend in crown dimensions with time. No significant differences were found between males or females, except root volume and surface area. Root length and surface area were observed to increase with sample age, but there was no correlation between root size and crown wear. Root size may correlate with occlusal loads due to food resistance, but was not linked in these cohorts to wear.

#### Geometric Morphometric Analyses of the Greater Sciatic Notch at Neale's Landing (46WD39) and Lyon's Bluff (22OK520): A Preliminary Study

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This study uses geometric morphometrics to analyze sexual dimorphism of the greater sciatic notch (GSN) in two samples of unknown sex. The sample from Neale's Landing (NL), a burial mound on Blennerhassett Island, West Virginia (AD 1290-1520), is comprised of 7 adults and 5 subadults, ages 0-16.5 years. The Lyon's Bluff (LB) sample totals 12 adults and 18 subadults recovered from this large mound village in Oktibbeha County, Mississippi (AD 1000-1650). A fan guide was used to digitize two landmarks and four semilandmarks on digital photos of the GSN in GIS. Procrustes analysis and principle component analysis was completed for site-specific and pooled adult samples. The first two principle components explain 94.38%, 95.20%, and 92.7% of the variation in the NL, LB, and pooled adult samples, respectively. K-means cluster analyses of the first two principle components with 2 cluster solutions show that the GSNs cluster according to shape in each of the adult samples. The narrower GSN cluster represents probable males; the wider GSN cluster represents probable females. Two NL GSNs that were included in the narrower GSN cluster of the single sample analysis clustered with the wider GSNs in the combined sample analysis, suggesting slightly similar, but overall population-specific levels of GSN sexual dimorphism. Subsequent k-means cluster analyses with 3 cluster solutions included the subadult data. For both NL and LB, the GSNs grouped into narrow adult, wider adult with older subadult, and younger subadult clusters, demonstrating similarity between subadult and female GSN shape.

#### Demography of the endangered Milne-Edward's sifaka (*Propithecus edwardsi*) in an unprotected degraded forest

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Compared to anthropoids, lemur sociality has puzzled primatologists due to a suite of behaviors including prevalent female dominance, even adult sex ratios, and lack of sexual dimorphism. Milne-Edward's sifaka (*Propithecus edwardsi*) moreover, forms groups with sociometric sex ratios consistent with monogamy, polygyny, polyandry, and polygamy in equal proportions within Ranomafana National Park (RNP), Madagascar. Data from other *P. edwardsi* groups however, are needed to examine the prevalence of this fluid grouping system. We examined a population of *P. edwardsi* in an unprotected forest north of RNP, known locally as Ampatsona and Ambohidaza (AA), which is heavily exploited for mining, timber, and agriculture. Thus, we predicted that group sizes would be smaller and compositions would differ from RNP due to habitat degradation in AA. We found 23 groups of *P. edwardsi* within AA, ranging in size from 1-8 individuals. Average group size was 3.9 individuals, lower than groups in RNP (5.3 individuals). 12 groups had sex ratios consistent with "monogamy" (i.e. one adult male and one adult female), 1 group with "polygyny", 1 group with "polyandry", 3 groups with "polygamy" and could not identify full compositions of the remaining 5 groups. These findings contrast with the more variable compositions in RNP, suggesting that anthropogenic disturbance can affect *P. edwardsi* group compositions. We suggest that this population merits immediate conservation action. Future work will more thoroughly examine effects of resource distribution, habitat disturbance, and kinship on group compositions using tree abundance, GPS, and fecal data collected in parallel to this study.

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#### **Trabecular morphology at the talocalcaneal and calcaneocuboid joints in StW 352 (*Australopithecus africanus*)**

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*Australopithecus africanus* has been interpreted as having an immobile and rigid lateral foot similar to that of modern humans. As one mechanism that contributes to a rigid foot during push-off in humans, supination of the talus on the calcaneus causes the talocalcaneal joint (TCJ) to become close-packed. While apes likely lack

TCJ supination, midfoot mobility and elevation of the proximal calcaneus may result in locally high compressive forces at the dorsal region of the calcaneocuboid joint (CCJ). We test the hypothesis that compressive joint forces acting on the calcaneus during push-off are preserved in the trabecular architecture at the TCJ in humans and at the CCJ in apes. We compare trabecular fabric properties in *Gorilla*, *Pan*, and *Homo* with those of an *A. africanus* (StW 352) calcaneus to address the evolution of these properties.

At the TCJ, trabeculae are thicker and significantly more anisotropic in humans than in apes. StW 352 TCJ trabecular thickness falls within the human range while anisotropy falls between human and ape ranges. In a DFA for the TCJ, StW 352 falls between non-overlapping human and ape groups. At the CCJ, BV/TV is higher in humans than in apes. StW 352 BV/TV falls within the human range. Anisotropy at the CCJ is highest in humans, with StW 352 falling below the human range, but within the ape range. The human calcaneus preserves trabecular evidence of stereotypical loading at the TCJ and CCJ. StW 352 exhibits more variable load orientations than humans but less variability than apes.

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#### **An examination of bio-distance between Late Woodland and Mississippian individuals from the northern Mississippian hinterlands using odontometric analysis**

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Mississippianization of the Midwestern United States took place circa AD 1050. Processes associated with these vast cultural changes are unknown and often attributed to trade, religion, or migration. The center of Mississippian cultural expansion is assumed to be the Cahokia site near St. Louis, Missouri. Biological distance (bio-distance) analysis examining skeletal assemblages from sites in the Cahokia area and adjacent Illinois River Valley have been previously conducted. These studies generally found biological continuity between the two time periods, with the resulting bio-distances affected more by geographic space than temporal and cultural transition. However, little bio-distance research has been conducted on sites located at the northern periphery of the Mississippian cultural landscape. This project provides an examination of three, non-neighboring sub-regions within the same cultural landscape, presenting a unique and broad examination of Late Woodland and Mississippian interaction in the Midwest.

In order to evaluate the biological continuity of the northern Mississippian hinterlands, this project examined the permanent dentition of approximately 870 individuals from three non-neighboring sub-regions located at the northern periphery of the Mississippian landscape using odontometric analyses. Results show that bio-distances between each site varied across the Midwest region and within each sub-region with no temporal or geographical pattern, despite the geographic range of the sites included in the project. Further, each site within the analysis was significantly different from the others in at least one dental measurement and biological variation was higher during the Late Woodland than the subsequent Mississippian period, likely as a result of geo-cultural barriers.

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#### **6 Million Years in 6 Minutes: Teaching Human Evolution in an Informal Museum Learning Environment**

JULIA M. ZICHELLO. Education, American Museum of Natural History.

Human Evolution is a complex topic; filled with nuance, plagued by misconceptions and marked by controversy. To rapidly and effectively communicate this information to museum visitors requires a set of cogent and compelling engagement strategies. The Sackler Educational Laboratory for Comparative Genomics and Human Origins at the American Museum of Natural History is a unique hands-on laboratory space within the Spitzer Hall of Human Origins. This lab gives the public the opportunity to engage with museum educators, handle fossil casts, and ask questions the exhibit hall cannot answer. Our visitors are diverse in their prior knowledge, cultural perspectives, and commitment to learning. We have developed a set of prompts, questions, and printed and digital materials that act to capture visitor attention, and deepen their understanding of human evolution, genetics and neuroscience. Here, we demonstrate how we have distilled big concepts into compelling educational learning materials, without sacrificing impact or accuracy.

*The American Museum of Natural History greatly acknowledges The Mortimer D. Sackler Foundation, Inc. for its support to establish the Sackler Brain Bench, part of the Museum's Sackler Educational Laboratory.*

#### **The Genetic Background of Atherosclerosis in Ancient Mummies**

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Despite the growing evidence for the presence of atherosclerosis in ancient human remains as shown by paleopathological, histologic and computed x-ray tomographic investigations, only limited data are available on the presence of genetic predisposition for cardiovascular disease in ancient populations. In a previous study of the 5,300-year-old glacier mummy from South Tyrol, commonly known as the Iceman or "Ötzi", an increased risk for coronary heart disease was detected by using next generation sequencing (NGS). The Iceman's genome revealed several single nucleotide polymorphisms, in particular located in chromosomal region 9p21 that are closely linked with cardiovascular disease in genome-wide association studies. CT scans of the Iceman already had revealed major calcification in carotid arteries, distal aorta, and right iliac artery, which are strong signs of generalized atherosclerotic disease. In an ongoing study, we have initialized further genetic studies of ancient humans from various geographic origins and time periods, including mummies from South America, Egypt and Europe. In this presentation, the different analytical steps are described, including sample preparation and DNA-extraction following strict procedures required for studies of ancient DNA, NGS of the mummy samples, including targeted DNA enrichment, library preparation and single nucleotide polymorphism (SNP) analysis and bioinformatic analysis of genetic risk factors associated with cardiovascular disease. The results have the potential to provide insights into the presence

and possible changes of genetic risk factors in our ancestors and aid in a deeper understanding of the interaction between environmental and genetic influences in the development of heart disease.

#### **Early food processing techniques and the mastication of underground storage organs (USOs)**

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Reduced dental and jaw size in the genus *Homo* suggests a shift to foods that require less masticatory effort to consume. Here we test the hypothesis that the adoption of early food processing techniques such as roasting, and slicing or pounding with a stone tool reduce chewing forces, and thus altered selection pressures on masticatory adaptations in *Homo*. Additionally, we test the degree to which the material properties of raw and processed foods can be used to predict chewing performance. 14 subjects (7F/7M) were fed size-standardized samples of three USOs (carrots, yams, beets) that were raw, sliced, pounded with a stone tool, or roasted. As the subjects chewed, surface EMG data were collected from the masseter muscle and then used to estimate forces. While slicing had no effect ( $p>0.05$ ; Wilcoxon signed rank test), both pounding, and to a greater extent roasting, reduced the average masticatory force used to consume the foods (~11% and 20% reduction respectively;  $p<0.01$ ; Wilcoxon signed rank test). These masticatory changes were strongly associated with the toughness and stiffness of the USOs ( $r^2=0.50$  and  $0.95$ , respectively). These results suggest that stone-assisted food processing may have allowed for early reductions of dental and jaw size within *Homo*, with further reductions being allowed by the adoption of cooking. Additionally, the strong relationship between material property and masticatory changes highlight the utility of measuring food properties to model hominin diets.

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#### **Lifetime reproductive effort and oxidative stress biomarkers in postmenopausal women**

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Recent studies on the trade-offs between reproduction and longevity indicate that the detrimental effect of oxidative stress may be crucial for the cost that reproductive effort incurs on lifespan in females. Every stage of reproduction causes major increases in oxidative metabolism that in turn may also elevate oxidative stress. Thus, it could be expected that increases in metabolism related to reproduction will contribute to maternal aging via increases in oxidative stress. However, to date, this theoretical prediction has been only occasionally studied in human females. To test the hypothesis that reproductive effort increases oxidative stress we conducted the study in postmenopausal women ( $n=100$ , mean age 64.0) from Mogielica Human Ecology Study Site in Poland. In these women high reproductive effort is accompanied by high energy expenditure resulting from physical work. We found that, independent of age, women with high lifetime gravidity ( $\geq 4$  pregnancies) had 20% higher levels of 8-OHdG (biomarker of oxidative damage to cellular DNA) and 60% higher levels of Cu-Zn SOD (biomarker of antioxidative defense) when compared to women with low gravidity ( $< 4$  pregnancies). This study presents the first clear evidence for oxidative stress as a cost of reproductive effort in humans.

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#### **Brain growth, energetics, and the slow life history of Neanderthals**

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Compared to present-day humans, Neanderthals are typically characterized as having followed a fast-track life history. Most data supporting this view come from comparative studies on dental maturation. The reconstruction of Neanderthal brain growth trajectories, however, yields opposing evidence. Growing larger-than-modern brains incurs higher metabolic costs, a substantial proportion of which has to be covered by larger, slower-maturing mothers. Here we investigate how the contradicting life-history implications from Neanderthal teeth and brains can be reconciled in the light of new empirical evidence on metabolic costs of brain growth and an infant's daily energy expenditure. Data on fossil endocranial volume increase can now be converted with fair reliability into rates of metabolic energy throughput. Also, data on dental maturation can tentatively be expressed in terms of changing energy source allocation. This metabolic approach permits to explore how evolutionary shifts in brain and dentognathic development influence infant, maternal and allomaternal energy flows, and life history

parameters of Neanderthals and present-day humans. Our analyses suggest that hominin life history evolution has more degrees of freedom than suggested by the slow-fast paradigm. Accordingly, the conflicting dental and neurocranial evidence regarding the pace of Neanderthal life history can be resolved by a revision of hominin life history theory.

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**Adapt or die: three case studies in which the failure to adopt advances from other fields has compromised paleopathology**

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Over the past several decades, the field of paleopathology has rapidly advanced, but a continuing delay in incorporating scientific advances and a lack of methodological rigor hinder its progress. While many scholars have argued that these tendencies prevent it from maturing into a scientific field, we highlight an additional consequence: the persistent use of non-standardized criteria and non-specific skeletal lesions to diagnose diseases, inconsistencies in the presentation of data, misuse of methods and techniques from other fields, and a delay in adopting relevant concepts and methods from other disciplines results in the publication of flawed studies peppered with 'possible' diagnoses. These accumulate into a growing body of methodologically unsound studies that obfuscates and unnecessarily prolongs debate about major research questions and slows scientific progress. Here, we demonstrate this phenomenon through a discussion of the impact of critically flawed studies upon three major research questions: 1) the origin and antiquity of syphilis, in which the publication of 'possible' cases makes it appear that there is dramatically more support for the Pre-Columbian hypothesis than actually exists; 2) identification of the causal pathogen of the Black Death, which a lack of methodological rigor has delayed by decades; and 3) the epidemiology of cancer in antiquity, estimations of which have been clouded by the use of non-empirical diagnostic criteria and a widespread failure to use relevant epidemiological methods. We conclude with recommendations that could facilitate a more rigorous, scientific approach to these and other important questions in paleopathology.

**The use of skeletal data for interpreting dental development in fossil hominins**

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A large body of research suggests that dental development was accelerated in fossil *Homo*, e.g., *Homo erectus*, Neanderthals and possibly early anatomically modern humans. However, dental development (specifically, dental formation) and skeletal growth are not conditionally independent given age. Therefore, it is important to determine whether the proposed faster rates of dental development in fossil *Homo* reflect faster rates of skeletal growth (and faster ontogeny overall), or if faster dental development in fossils is independent of their skeletal growth rates. I use comparative data from recent modern human subadults (N=181) of known age with associated dental and skeletal elements to develop predictive models to which fossil hominins can then be compared. There are only five fossil *Homo* subadults of known chronological age (estimated from dental microstructure) with associated permanent dentition and skeletal elements: KNM-WT 15000 *H. erectus/ergaster*, Dederiyeh 1 and Le Moustier 1 Neanderthals, and Qafzeh 10 and Lagar Velho 1 modern humans. The results suggest that dental formation in KNM-WT 15000 generally matches the expectations given its age and skeletal growth. Molar development in Dederiyeh 1 is as expected, whereas Le Moustier 1 exhibits more advanced stages of molar development, given their age and skeletal growth. Both Qafzeh 10 and Lagar Velho 1 show unique differences in predicted relative to observed stages of dental development when age and skeletal growth are considered jointly. These results suggest that a consideration of skeletal growth together with chronological age can provide valuable additional information for interpreting dental development in fossil hominins.

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